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ABSTRACT

This document presents a field hearing of the Governmental Affairs Committee to examine the current reform efforts in science and mathematics education at the federal and state levels, focusing specifically on the experiences of Ohio. Nine witnesses representing various educational levels presented testimony concerning mathematics and science education initiatives in Ohio. Initiatives and issues discussed included: (1) the Ohio Proficiency Test; (2) Project Discovery, a project focusing on preparing middle school students to think critically and solve problems; (3) the National Center for Science Teaching and Learning; (4) curriculum reform; (5) societal factors influencing reform; (6) collaboration among the higher education, public education, and business sectors; (7) the B-WISER Institute, a summer camp and follow-up program that empowers young women to achieve in science; and (8) the under-representation of minorities and women in mathematics and science. Appendices contain copies of prepared statements by the witnesses and other participants. (MDH)

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SCIENCE AND MATH EDUCATION REFORM

ED 362 395

HEARING

BEFORE THE

COMMITTEE ON GOVERNMENTAL AFFAIRS UNITED STATES SENATE

ONE HUNDRED SECOND CONGRESS

SECOND SESSION

JULY 7, 1992
(Cleveland, Ohio)

Printed for the use of the Committee on Governmental Affairs

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FIELD HEARING ON SCIENCE AND MATH EDUCATION REFORM

TUESDAY, JULY 7, 1992

U.S. SENATE,
COMMITTEE ON GOVERNMENTAL AFFAIRS,
Washington, DC.

The Committee met, pursuant to notice, at 9:30 a.m., at NASA Lewis Research Center, 21000 Brookpark Road, Cleveland, Ohio, Hon. John Glenn, Chairman of the Committee, presiding.

Present: Senator Glenn.

OPENING STATEMENT OF SENATOR GLENN

Chairman GLENN. The hearing will be in order. This is an official meeting of the Governmental Affairs Committee that I chair in Washington. We hold field hearings on occasion in different states when there is an issue that a particular state has expertise that would be of benefit to us and where we could gain more by having a field hearing than just calling people to Washington for the usual routine hearing there. A record is being kept, and the report will be made and filed of the proceedings here today for the rest of the Committee and for the staff in Washington. We particularly appreciate all those who are willing to take part in the hearing today.

Today we will examine the current reform efforts in science and math education at the Federal and state levels. The Governmental Affairs Committee has oversight jurisdiction with regard to the efficiency, the economy, and the effectiveness of all Federal agencies. That's a big order when you're talking about the Federal Government. This includes the Department of Education, and the National Science Foundation. Additionally, our jurisdiction also includes the study of the relations of state and local governments with the Federal Government.

We will focus specifically upon the experiences of Ohio. I'm very pleased that the Committee is holding this hearing in Cleveland and, in particular, at the NASA Lewis Research Center. In surroundings like these at this center, we are reminded of our country's successes some years ago in space and the ones going on even today. The crew of the space shuttle Columbia, in the longest shuttle flight yet, will be returning tomorrow morning after a mission that concentrates specifically on scientific projects. We're reminded of what went into that success, all the study, all the math, all the science, and all the engineering.

Going back in the early 1960s, John Kennedy made the statement, "Now is clearly the time to take longer strides—time for a

new American enterprise—time for this nation to take a leading role in space achievement which, in many ways, may hold the key to our future on earth." So we're very glad to be here at NASA Lewis this morning.

President Kennedy's words are equally true today when we think about reforming science and math education. It is past time for this nation to commit itself to improving our educational systems across the board and to improve math and science education in particular. And all of our witnesses and spectators believe, as I do, that education is the fuel which has propelled the United States to world leadership in the 20th century. If we are to retain this leadership in the 21st century, we can't be satisfied with the status quo.

In many speeches, I've challenged an audience to say, "What do you think? If you had to name two things that made this country great, what would they be?"

And someone always says, "Well, we had great resources." And it's true. We did. We had the fruited plain and purple mountains' majesty and majestic rivers flowing to the sea that we sing about. But my two nominees would not be just our resources because many places in the world had great resources and did not develop the way we did. I would submit that the first element was education. Education in this country was not just for the kids from the castle, or the rich, or the politically connected. It was for everyone. And out of that came a more generally educated public than any place in the world had ever had.

The second element was that we put more of our gross national product back into fundamental, basic, Nobel prize-oriented, breakthrough-type research. We made those breakthroughs with an educated citizenry. Things just sprouted. We had businesses and industries and entrepreneurship and new jobs, and we just jumped ahead of the new world in a tiny little time frame in history.

I don't think that it's any accident that other nations are beginning to emulate us, beginning to do exactly what we have done, and in some cases are beginning to outdo us, particularly in the area of education. It's come to the forefront in recent years. If we're to be competitive in the future, it's going to be because we decided that we're going to outcompete anybody else in these areas I still think education and research are the keys to our future as they have been in the past. We want to be number one, not just to wave a big styrofoam finger in the air like we do after a ball game and say "We're number one! We're number one!" Being number one as a nation means we determine our own future. We're not beholden to anyone else. We're the ones that make the decisions on what the future of this country will be. To me, that's the importance of the subject we're focusing on today.

There are many roadblocks in our way as we travel down this road of education reform. Money's tight. America has been mired in a recession, as we're all aware. The result of this recession is that Federal and state and local governments have been forced to cut back on spending, and education often takes the hit.

Right here in Ohio, just last week, the state government was forced to cut $170.2 million from its higher education budget.

Sadly, this type of cut is all too familiar nowadays. It is certainly going to cost us, I think, further down the road.

Earlier this year, the Senate passed numerous educational goals, goals designed to address reform in S. 2, the Neighborhood Schools Improvement Act, which I cosponsored.

Setting of goals is easy. We can all set great goals. But achieving them is another matter. And one of the purposes of the hearing today is to hear from educators on the front lines as to what ideas work, what ideas don't work, and improving the education of our young people. I look to this hearing for guidance so that when I am back in Washington and these issues come up, we will have ideas on how we're going to promote the educational goals of this country. Additionally, we will have an idea of what works and what does not.

In particular, science education has never been more vital to the progress of our daily lives, to the State of Ohio, and to this nation. Our businesses, our factories, and laboratories will continue to need a first-rate technical workforce to compete in the world. We can't afford to slip in this regard.

I read a book a short time ago by Lester Thurow, who is Dean of the School of Economics at the Massachusetts Institute of Technology. It's called *Head-To-Head: The Coming Economic Battle Among Japan, Europe, and the United States.* He analyzes the coming competition as he sees it going into the next century between our country and between the Nations of Europe that are becoming united in EC, European Community 1993, which, if they work out their problems, is going to start up next January 1st. It will be 343,000,000 people as one entity, one economic block, and Japan as a third element. The book analyzes what we're doing with regard to education, how we're going to be able to compete or not compete into the next century. So this issue is very key to us right now.

I've sponsored legislation in the Senate to make science and math education more attractive and effective for our nation's students. We did this after consulting with educators both here in Ohio and across the country. These proposals have included creating regional consortia for science, math, and technology education and establishing a national clearinghouse for science, math, and technology education. Some of that targeted the teachers. We found in talking to a lot of people that many of the things move ahead so fast in science and technology that sometimes the teachers have a problem keeping up.

We created Congressional scholarships for science, math, and engineering students. Also, this year I've introduced S. 685, the Summer Residential Science Academy Act for intensive multi-year science camps throughout the Nation. This bill would create summer science academies for talented and economically disadvantaged minority students. A companion bill has been introduced in the House of Representatives by Congressman Louis Stokes. The entry of minority students into the science pipeline is too small. We must give bright and talented young people a fighting chance to break out of the vicious circle of crime and poverty plaguing our inner cities.

The total increase in Federal expenditures for all science and math education for fiscal year 1990 through the administration's

fiscal year 1993 request is 43 percent. It sounds pretty good. Except it started at too small a base. So, a 43 percent increase is not that huge an outflow of money to do the things that need to be done.

Now we need to find out how this increase has affected education at the grassroots level, which is really why we're holding this hearing today.

I know that Ohioans are working hard to improve education in this state. Two years ago, there was the Ohio summit on math and science that was entitled "Reform Is Your Business." Ohio has demonstrated a commitment to revolutionize and reform and a willingness to collaborate to achieve the goals. And collaboration is key, given the fiscal constraints of today's economy. These efforts to reform how science and math are taught will enable our Ohio students to compete better in the future.

It's important to emphasize that the entire American work force will need to have its skills upgraded, not just those who intend to pursue a mathematics, science, or engineering career. And our goals should be to ensure that all our students are reaching their maximum potential, not just in science and math but all their educational curriculum.

I read a figure the other day that I want to double check. It was in a newspaper article that I read, and I haven't double checked this yet, but it was written that 10.1 percent of our high school graduates are functionally illiterate . . . 10.1 percent. I can't believe it's that high. But that's a figure that must scare us in addition to the math and science difficulties that we have in teaching if that figure is accurate.

According to census figures and the Department of Labor's *Workforce 2000* report, our national workforce will be different in nine years. It will be more diverse; it will contain more women; it will contain more minorities; and it will require more technological expertise. Therefore, the future economic success of the Nation is dependent on insuring that women and minorities have a full range of career choices open to them.

One recent reform Ohio implemented is the ninth grade proficiency test in mathematics. Science testing at the ninth grade level will be added in 1995. According to testimony provided for today's hearing by Dr. Ted Sanders, Superintendent of Public Instruction at the Ohio Department of Education, results for the Ohio Proficiency Test in mathematics for the class of 1994 indicate that only 43 percent of Ohio students passed on their first attempt; and only 68 percent have now passed after four attempts on the test. Also, poorer school districts are more likely to have lower pass rates than the statewide statistic. So it will take an effort by all of us to turn this around.

On the road to science and math literacy, no child—black or white, male, female, rich, poor—should be left stranded.

Ohio has taken seriously the need for reform of the science and math education curriculum. I commend the many programs that are taking up the challenge to bring science and math literacy to every Ohio student. Of course, we just didn't have the time and couldn't provide a forum today for all of the innovative program creators and teachers and students to testify, but we do appreciate the assistance in particular of the Cleveland Public Schools, Tri-C,

the Ohio Academy of Sciences, NASA Lewis Research Center, Quality Education for Minorities, and many others for their willingness to serve as resources for the Committee.

We look forward to the testimony of our witnesses this morning on the challenges facing Ohio and the collaborative efforts of the entire Ohio community to transform science and math education. And in particular, before we move on, I would be remiss if I didn't express our particular appreciation to the staff of NASA Lewis Research Center and the Cleveland community for their hospitality and for helping us put this together today.

PREPARED STATEMENT OF CHAIRMAN GLENN

This morning the Governmental Affairs Committee will examine the current reform efforts in science and mathematics education at the Federal and state levels. The committee has oversight jurisdiction with regard to the efficiency, economy and effectiveness of all Federal agencies, including the Department of Education and the National Science Foundation. Additionally, our jurisdiction also includes the study of the relations of state and local governments with the Federal Government. Today, we will focus specifically upon the experiences of Ohio and I'm pleased the committee is holding this hearing in Cleveland at the NASA Lewis Research Center.

In surroundings like these, we are reminded of our country's successes in space and we are reminded of what went into that success. In the early 1960's, to inspire the Nation to work hard and excel in space technology, President John F. Kennedy said, now is clearly the time to take longer strides—time for a new American enterprise—time for this nation to take a leading role in space achievement, which in many ways may hold the key to our future on earth.

President Kennedy's words are equally true today when we think about reforming science and mathematics education. It is past time for this nation to commit itself to improving our educational systems across the board, and to improve math and science education in particular.

I know all of our witnesses and spectators believe as I do that education is the fuel which has propelled the United States to world leadership in the 20th century. But we also know that if we are to retain this leadership in the 21st century, we cannot be satisfied with the status quo.

But there are many roadblocks in our way as we travel down this road of education reform. Times are tight. America has been mired in a recession our own President wouldn't admit existed until just recently. A result of this recession is that Federal, state and local governments have been forced to cut back on spending, and education often takes the hit.

In fact right here in Ohio just last week, the state government was forced to cut $170.2 million from its higher education budget. Sadly, this type of cut is all too familiar nowadays, and it may cost us further down the road.

Earlier this year, we in the Senate passed numerous educational goals designed to address reform in S. 2, the Neighborhood Schools Improvement Act, which I cosponsored.

Setting goals is easy. Achieving them is another matter. Today, I want to hear from the educators on the front lines as to what ideas work and what ideas don't work in improving the education of young people.

In particular, science education has never been more vital to the progress of our daily lives, to the state of Ohio, and this nation. Our businesses, factories, and laboratories will continue to need a first rate technical workforce to compete in the world. We cannot afford to slip in this regard.

That's why I have sponsored legislation in the Senate to make science and math education more attractive and effective for our nation's students. These proposals include: creating regional consortia for science, math and technology education; establishing a national clearinghouse for science, math and technology education; and, creating congressional scholarships for science, math and engineering students.

Also this year I have again introduced S. 685, "The Summer Residential Science Academy Act" for intensive, multi-year science camps throughout the Nation. This bill would create summer science academies for talented and economically disadvantaged minority students. A companion bill has been introduced in the House by Congressman Louis Stokes.

The entry of minority students into the science pipeline is too small. We must give bright and talented young people a fighting chance to break-out of the vicious circle of crime and poverty plaguing our inner-cities.

The total increase in Federal expenditures for all science and math education for fiscal year 1990 through the administration's fiscal year 1993 request is 43 percent. Now we need to find out how this increase has affected education at the grassroots level, which is why I'm holding this hearing today.

I know that Ohioans are working hard to improve education in this state. Two years ago, there was an Ohio summit on math and science entitled "Reform Is Your Business." Ohio has demonstrated a commitment to revolutionize and reform, and a willingness to collaborate to achieve the goals. Collaboration is key given the fiscal constraints of today's economy. These efforts to reform how science and math are taught will enable our Ohio students to compete better in the future.

It is important to emphasize that the entire American workforce will need to have its skills upgraded, not just those who intend to pursue a mathematics, science, or engineering career. Our goal should be to ensure that all of our students are reaching their maximum potential. Not just in science and math, but in all of their educational curricula.

According to census figures and the Department of Labor's *Workforce 2000* report, our national workforce will be different in nine years. It will be more diverse; it will contain more women; it will contain more minorities and it will require more technological expertise.

Therefore, the future economic success of the Nation is dependent on ensuring that women and minorities have a full range of career choices open to them.

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It will take an effort by all of us to turn this around.

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Ohio has taken seriously the need for reform of the science and math education curricula. I commend the many programs that are taking up the challenge to bring science and math literacy to every Ohio student. Unfortunately, we could not have all of the innovative program creators, teachers, and students testify today. We appreciate the assistance of the Cleveland public schools, Tri-C; the Ohio Academy of Sciences, NASA Lewis Research Center, Quality Education for Minorities, and many others, for their willingness to serve as resources for the committee.

Our first panel will include: Chancellor Elaine Hairston, of the Ohio Board of Regents, accompanied by Dr. Jane Kahle, of the University of Miami; Dr. Kenneth Wilson, Hazel C. Youngberg Trustee Distinguished Professor, a Nobel Laureate in Physics, I might add. Dr. Wilson is also a principal investigator for Project Discovery; Dr. Arthur White, Director of the National Center for Science Learning and Teaching in Columbus. The center is funded by the U.S. Department of Education and is the only one in the country; and Dr. Sammie Campbell Parrish, the new superintendent of Cleveland Public Schools. The following panel will be Dr. Jim Porter, Superintendent of Lake County Public Schools; and Dr. Michael Salkind, of the Ohio Aerospace Institute. The third panel includes, Dr. Prem Batra of Wright State University; Dr. Gardenia Butler, Executive Director of Minorities and Mathematics, Science and Engineering; and Ms. Elizabeth Obara, Camp Director of the B-Wiser Institute of the Ohio Academy of Science.

We look forward to the testimony of our witnesses this morning on the challenges facing Ohio and the collaborative efforts of the entire Ohio community to transform science and math education.

The committee appreciates the staff of NASA Lewis Research Center and the Cleveland community for their hospitality.

Chairman GLENN. Our first panel this morning is entitled "Science and Math Education Reform Issues." And as I read these names, if the people would take their places at the witness table across from me, I would appreciate it.

Dr. Elaine Hairston is the Chancellor of the Ohio Board of Regents. She administers the Ohio Mathematics/Science Project Discovery, a National Science Foundation statewide systemic initiative.

Dr. Kenneth Wilson is Youngberg Professor at the Ohio State University and is a distinguished Nobel Laureate. He is co-principal investigator for Project Discovery.

Dr. Arthur White is the Director of the National Center for Science Teaching and Learning. This center is located at the Ohio State University, and it is the only one of its kind funded through the U.S. Department of Education.

Dr. Sammie Campbell Parrish is the new Superintendent for Cleveland Public Schools. She joined the Cleveland Public School administration on July 1st, 1992. This hearing gives her the opportunity to speak on her ideas and plans for science and math education reform.

So we welcome all of you this morning and look forward to your testimony, your advice, and your counsel on this because you are the ones who are on the front line of what we're doing here in Ohio. This is a hearing of a Congressional committee of the Federal Government, so it's not just an Ohio committee. I hope to take back a record today that can help us look into some these things on a national level.

Dr. Hairston, if you would lead off with your testimony, I would appreciate it very much.

TESTIMONY OF ELAINE H. HAIRSTON,[1] CHANCELLOR, OHIO BOARD OF REGENTS

Dr. HAIRSTON. Good morning, Senator Glenn, and thank you for coming to Ohio to hear what we are engaged in. We have many exciting ideas to share with you.

Chairman GLENN. If all of you would pull those mikes up fairly close to you, everyone can benefit from what you are saying.

Dr. HAIRSTON. Let me begin by saying that the State of Ohio and the Ohio Board of Regents have a long history of working collaboratively with K-12/higher education linkages in addressing the serious challenges facing today's students as they prepare to take their place in a society that is increasingly advanced technologically. Our world today and the world that our children will provide leadership for in the future is one that demands a high level of skill in approaching and solving problems through the ability to think critically and creatively and through the effective use of technology.

It is well documented that mathematics education and science education in the United States have fallen seriously behind that in other nations. And Ohio is no different than her sister states in this regard. While Ohio ranks sixth among the states in science and technology-based industry and ninth in the number of small firms active in high technology, Ohio schools rank in the mid-20s in mathematics, science, and technology education. The need to increase the achievement level for all students, but especially stu-

[1] The prepared statement of Dr. Hairston appears on page 57.

dents from underrepresented groups who will become the majority of the next century's work force, heightens the urgency for action if we are to prepare students to take their place in the work force of the future.

Project Discovery, Ohio's statewide systemic initiative in math and science education, focuses on preparing middle school students for these challenges by developing their ability to think critically and to analyze problems and find solutions using the principles gained in the study of mathematics and science. As such, it builds on exemplary resources of K–12 and higher education and stands firmly on the shoulders of dedicated educators and community leaders, who, 15 years ago, were on the leading edge of the reform effort that is currently sweeping this nation today.

Today, I want to give you a brief overview of Project Discovery and its importance to Ohio. But first, let me say that Project Discovery is predicated on a long history of concern about academic preparation of students in mathematics and science and is built upon the lessons that we have learned from past initiatives. From our early efforts, we have gained a sense of some of the essential ingredients for long-term change: collaboration; strong K–12/higher education linkages; early intervention; an investment in how students learn as well as what they learn; and finally, the importance of demystifying math and science for these young minds, replacing fear and uncertainty with the excitement of healthy engagement, with the challenges of those areas of study and what they have to offer, and the confidence that comes through continuous improvement rather than through continual failure.

More than 15 years ago, we became concerned about the academic preparation of students as they were leaving high school and entering college. At that time, a concerned faculty member at Ohio State University and a high school mathematics teacher in Columbus began a dialogue in 1978 that blossomed into the Early Mathematics Placement Testing Program. This program, begun as an experiment in one Ohio high school, is now an integral part of Ohio's reform efforts in over 600 high schools and all college major colleges and universities as we seek to identify students' mathematics deficiencies in their junior year of high school, time enough for students to correct those deficiencies in order to enter college with a solid foundation and greater chance of academic success. The Early Mathematics Placement Testing Program also influences mathematics curriculum revision in schools. The program has garnered the attention of at least 20 other states who have since replicated it. And in a successful win-win strategy, this, between schools and colleges, is done at a very low annual cost of $175,000 to test over 60,000 high school juniors in the State of Ohio annually. It is a real bargain.

The Early Mathematics Placement Testing Program stimulated a statewide dialogue between the Ohio Board of Regents and the Ohio Department of Education, among educators at all levels around the state who were generally concerned about the success of students in making the transition from high school to college. The result was the development of a recommended course of study for students so that they could be clear about the minimum expectations for academic preparation as a prelude to college level work.

This provided an important tool in increasing student academic success by providing a clear sense of direction and opportunities for feedback between secondary education and the collegiate experience. It became yet another cornerstone of Ohio's reform efforts.

As you can see, early intervention strategies and initiatives in the areas of math and science education and generally in education reform focused on the high school to college transition, and these efforts are essential. However, they do not sufficiently address the deepening concerns we all share about the adequate preparation of students in math and science. If we are to truly shape the future and prepare today's students for tomorrow's work place challenges, we must reach young minds early in the formative educational years and transform the way students and teachers approach math and science education. We must demystify the learning process and fully engage students in how one critically analyzes problems, providing them with opportunities to find out for themselves how and why things work and to allow them to become experts in taking knowledge gained in the classroom and in lab experiences into other arenas, a skill that will not only enhance their math and science education, but one that has a far-reaching impact into all academic disciplines and will provide an ability to provide effective and informed leadership and inspire future technological advances that will be essential in assuring a competitive advantage for our state and our nation.

Through the Federal funding provided by the Dwight D. Eisenhower programs in math and science education, we're able to begin to set the wheels of change into motion and to stimulate elementary and secondary school teachers in collaboration with colleagues at schools and colleges to design the kind of learning experiences that would excite and challenge young students while providing them with the necessary academic support to be successful in their endeavors. These efforts have been further enhanced through such programs as the Teacher Leadership Consortium, an initiative funded by the Ford Foundation and the Cleveland Foundation, that focuses on the professional development of the teacher and specifically on bringing colleges of education across this state into the designing efforts to increase the number of minorities recruited, graduated, and retained as teachers in Ohio.

As you can see, the improvement of mathematics and science education is and remains a high priority in Ohio and with the Ohio Board of Regents. When the call for programs came from the National Science Foundation in 1990, we were ready to respond to the request to develop a statewide systemic initiative in the area of mathematics and science education. We had learned the importance of collaboration and early intervention from our past efforts. We had learned the importance of providing young students with new kinds of learning experiences in an invigorating learning environment. We had learned the value of developing teachers to design these kinds of experiences and the importance of increasing the numbers of minority and women educators as a prelude to encouraging the flow of underrepresented groups into the mathematics and science pipelines. We had learned how to join hands in order to work with our K-12 colleagues for an effective change. We had joined hands rather than pointing fingers. It was time for us to

take what we had learned and move to the level of the individual classroom or teacher for effective systemic change across the system—change that would ultimately reach into every science and mathematics classroom across the state.

The National Science Foundation statewide systemic initiative provided us with the opportunity to develop this kind of statewide change, and thus, Project Discovery was born. The past two years have been very exciting for us. We were extremely pleased to be one of the first ten states awarded funds through NSF for this kind of venture. Project Discovery represents a major turning point in our history of efforts to effect change in math and science education.

Through available funding, our previous initiatives were only able to provide short-term interventions and locally based programs, such as workshops to enhance classroom teaching techniques or curriculum design in a specific classroom or school system. The NSF funding opportunity challenged us to define a more comprehensive, statewide, long-term approach to improve the teaching of math and science.

Project Discovery provides us with the opportunity to integrate many of Ohio's existing initiatives, resources, and personnel, and to provide a comprehensive approach in working toward a common goal. Instead of isolated initiatives which address an individual teacher or school or issue, we were challenged to bring together groups of teachers, groups of educators, administrators, faculty, legislators, parents, students, and community leaders, to collaboratively define problems and design strategies and structures that would be broad-based and sustaining. Coordinated at the statewide level, but based in the local communities. Let me caution that the orchestration for change is not easy, but then nothing worth having usually is.

In its early phases, Project Discovery is focusing on the training of existing middle school teachers through professional development activities in mathematics, science, and in the teaching/learning process itself. These teachers will then take that knowledge into the classroom as they design experiences for students that will encourage the student to learn mathematics and science by doing mathematics and science and discovering for themselves how and why things work.

We expect that one of the outcomes of this project will be that students graduating from middle and junior high schools and entering any high school curriculum, be that college preparatory or the vocational technical curriculum, would have a basic scientific and mathematical literacy and would have significantly enhanced ability to succeed in any relevant mathematic, science, or technical course, and, in fact, will have an excitement and enthusiasm for mathematics and science. They will be confident learners.

Integral to Project Discovery is the concept of collaboration and partnership. We are fortunate to have a committed leadership of unparalleled strength at the statewide level through the efforts of the project's principal investigators and project directors: Dr. Kenneth Wilson, Nobel Laureate in physics and Professor at the Ohio State University; Dr. Jane Butler Kahle, who sends her sincere regrets not being able to be here this morning. She is the leading

international scholar in science education at Miami; Dr. E. Garrison Walters, Vice Chancellor at the Ohio Board of Regents; and Dr. Nancy Eberhart, Director of the Division of Curriculum and Instruction and Professional Development in the Ohio Department of Education. Governor Voinovich, Dr. Ted Sanders, the State Superintendent of Public Instruction, and I have also pledged our full support to this project. And I would add that even in this time of budget and fiscal difficulty for the State, the funds that match Project Discovery have remained intact.

The real heroes in this project, however, are the committed parents, teachers, legislators, community leaders, and students who take these innovative approaches to teaching science in the classroom and whom join together in designing efforts to address the specific needs of their particular region of the state.

Project Discovery has provided a mechanism for different sectors to work together, rather than in isolation, to define issues and design strategies. It has become a catalyst in bringing diverse groups together with a common goal. It has encouraged the creation of new linkages and it has solidified others. Importantly, it has brought K–12 and higher education sectors together to create an infrastructure that will encourage solution across educational boundaries. This regionally based structure will help fund other initiatives to work together through Project Discovery to maximize the use of financial resources and to share professional expertise.

Project Discovery has also provided a mechanism for increasing public awareness of the fundamental importance of mathematics and science to the Nation's current and future standard of living—a strategy that will not only serve today's students, but tomorrow's students as well.

Senator, we feel fortunate in Ohio to have received this generous grant from the National Science Foundation and urge that such programs be continued. However, the problems facing our schools are such that they are deep-seated and serious. They cannot be fixed with one project with five-year funding. Systemic change will occur only with the help of all stakeholders working together and through long-term efforts. Collaboration is time-consuming and sometimes difficult, but well worth the price in creating strategic and innovative approaches. And the future of our nation is in preparing students for these challenges. I applaud the National Science Foundation on its bold approach to reform in mathematics and science and urge that broad-reaching initiatives such as the State Systemic Initiatives Program be encouraged and supported so that our students can be at the top in mathematics and science by the year 2000.

I would be pleased to answer any questions you have and certainly defer to any of the members of this panel in answering them as well.

Chairman GLENN. Thank you very much. What we'll do is have all the statements first, and then we can have the discussion.

Next, Dr. Kenneth Wilson. Ken, we're glad to have you here this morning.

TESTIMONY OF KENNETH G. WILSON,[1] HAZEL YOUNGBERG TRUSTEES DISTINGUISHED PROFESSOR, OHIO STATE UNIVERSITY

Dr. WILSON. Thank you. It is certainly my pleasure to be here and to be part of all the other testimony taking place later, which will show you the full strength of efforts in Ohio that Chancellor Hairston has alluded to.

I would like to repeat that Discovery has tremendous support both from the National Science Foundation to the Statewide Initiative Program and from the State, which has committed $4 million from its current biannual budget to the project, despite the budget cuts that our state faces. In my five minutes, I cannot possibly do justice to what is a very complex program, and I just want to say very briefly, the collaborations that are required by Discovery in all eight regions around the state are diligent. It is an awesome task. The people involved are not used to having to come together across anywhere from 5 to 13 counties to collaborate, but the support from the grassroots to the community leaders throughout these collaborations is just amazing, especially when they have to work under high pressure.

Leadership teams to serve the northeast region, including Cleveland, are already in training at The Ohio State University, where they are learning about inquiry in a summer workshop with teachers from all around the state. And the morale and excitement in those workshops is amazing to behold. It includes everything, everybody from very experienced professors and master teachers—we call them teacher leaders—to teachers who suffer the handicap of elementary school certification, which means in many cases not even a high school education in mathematics and science. But everybody is learning together. Everybody is collaborating. Everybody is having fun and learning through the inquiry mode.

I would like especially to thank those members of the northeast collaboration who are actually here, such as Barbara Patterson, Jim Porter, and there are many others who have contributed to the success of the northeast collaboration, including the selection of the leadership teams which are now in training.

I also have to thank the tremendous support that I have received for my role in the project from The Ohio State University, from the dedicated faculty and staff who have prepared for the summer workshops and are leading them to the support that I received from the School of Education. People have been amazed to see me frequently in the library of the School of Education as I learn what systemic reform is all about. And President Gee has given solid support, including the commitment of six faculty positions in mathematics and science education to the project. But I must move on.

You, Senator Glenn, have asked us what further support we need from the Federal agencies in order for Project Discovery to be a success, especially in the long term, which is where educational reform projects run into difficulty. The big problem that we face is that we will be bringing growing numbers of teachers, as the regional collaborations get going, to six-week summer workshops

[1] The prepared statement of Dr. Wilson appears on page 67.

where they will feel the excitement of learning the principles of mathematics and science largely through their own discussions rather than being lectured at. But then they have to go back to the schools, to the schools with bureaucratic inertia and delay, to schools in urban environments where often they are mired in despair and conflict, where the teachers have to work alone because there is no collaboration.

The first thing that I ask of you, Senator Glenn, is that we not declare the urban education problem to be hopeless. You will hear many examples here of the eagerness of children to learn in the worst possible environments. I have myself seen an amazing program called "Reading Recovery," which is a program that started at Ohio State University, is now in many schools in Ohio, but is in 42 states in the Nation. In that program, highly trained teachers who go through a year of in-service training are taking children in first grade at risk of failing throughout their careers in school and bringing their reading skills up to the average of the rest of the class. Those kids are overcoming all their difficulties of the environments they live in to learn to read as well as the rest of us read.

I have visited the Bernard Harris Elementary School in Baltimore, where I have seen all the children in that school listening to each other read in pairs, maintaining an exemplary discipline. That is an example of a whole school restructuring program called "Success For All." And they have developed expertise which is the envy of schools nationwide to deal with the problems that children bring with them to school. I hold in my hand the Success For All Family Support Team Manual. This manual is filled with the expertise that most schools do not have access to. Those teachers who struggle with the problems that children come to school would be helped by all the procedures in this manual, but they don't have access to this manual. And they don't have access to the years of experience in these restructuring programs. But it is because of these experiences that I ask you not to let hopelessness triumph.

My second point, Senator Glenn, is we have spent over 20 years providing supplemental funding through the Chapter 1 program to schools with high proportions of disadvantaged students. Why was it necessary to put supplemental funding into those schools? Why was it necessary? No one knows the answer to that question. Let me explain why that is.

When we have problems elsewhere, such as an airline crash, we all know about the crack investigation team that goes and finds the black box that has the records from which we find out why that crash occurred. The expert team will figure out what problem in our entire air transportation system was the cause of that crash and will recommend how to fix the problem. And it takes one investigation that sifts through the evidence to come to a conclusion which we all accept.

In education, since the publication of *A Nation At Risk*, we have had over 100 reports of what went wrong, what needed to be done, but we still do not have a diagnosis of what is wrong with our present educational system with the evidence to support it that has the same credibility of a single report of an airline crash. We do not have a black box which everybody trusts to tell us what is

going wrong with our present education. The National Academy of Sciences has never been asked to perform a study of this problem; that is, to investigate the diagnoses which have been proposed for the failure of our education system and to look at whether there is evidence that either supports or refutes those diagnoses. Senator Glenn, the National Academy of Sciences awaits your call.

Finally, I return to the Chapter 1 program. I have already mentioned the expertise that is being built not just at the Bernard Harris Elementary School, but in exemplary schools in urban areas and also in rural areas around the country. But I have talked to Robert Slavin, who is the leader of the Success For All Program, and he told me the difficulties that he still faces in building up enough expertise to really deal with the problems to the level of bringing the Bernard Harris Elementary School to the point where it can meet the National goals, including the National goal to be number one in mathematics and science. You can help by arranging a set-aside from the existing Chapter 1 funding so that some of that money will go to the further development of expertise to deal with the problems that the children bring to school, to deal with the learning problems that they have, and to help to diffuse that expertise to schools all across the country, including here in Ohio. And Discovery needs access to the expertise that could be built through such a set-aside program so that we can make it available to our eight regional collaborations so we can distribute it to schools and so we can help the teachers when they go back to their schools, go back with the expertise, not simply in mathematics and science, which we will supply, but with the expertise to deal with all the other problems that beset our schools.

And I would emphasize, Senator Glenn, that the movement to systemic reform is in its very early stages. It cannot absorb large sums of money. We do not have the people with the expertise to spend it yet. But we need the people who already have the expertise to continue to have growing funding so that their work—and this includes Robert Slavin, James Comer of the School Development Program, Ted Sizer of the Coalition of Essential Schools, it includes Henry Levin of Accelerated Schools, and other schools like that around the country—they need modest sums of money but growing over time so that the expertise they already have developed can be improved and made available to all of us.

Thank you.

Chairman GLENN. Thank you very much, Dr. Wilson.

Dr. Arthur White?

TESTIMONY OF ARTHUR WHITE,[1] DIRECTOR, NATIONAL CENTER FOR SCIENCE TEACHING AND LEARNING

Dr. WHITE. I would first like to thank you, Chairman Glenn, and other distinguished members of this committee for your invitation to appear here today.

My name is Arthur White. I began my formal education in a two-room rural school in Colorado. And now I'm a professor of education at the Ohio State University and Director of the National

[1] The prepared statement of Dr. White appears on page 91.

Center for Science Teaching and Learning. N-C-S-T-L or NCSTL is our acronym. I understand that the topic for this hearing is the impact of national reform efforts in science and mathematics education in the State of Ohio. I will be speaking specifically about the research efforts of the Center and, in general, about our concerns regarding the research base underpinning these reform efforts and the relationship between research and reform.

The NCSTL is one of 23 research centers funded by the Office of Educational Research and Improvement of the U.S. Department of Education. We conduct research into what we call external factors, factors that affect science education that are outside the general control of the teacher in the classroom. The National Center is dedicated to supporting research that will result in improvements in science teaching and learning. To that end, the Center is divided into five research-focused areas: social and cultural factors; the second is public expectations and societal incentives; the third is school organization, economic and political forces; the fourth is new technologies; and the last, curriculum integration.

I would like to spend just a few moments outlining the research efforts in each of these areas over the last 18 months of our existence and then move into a discussion of how we perceive the relationship between research and reform.

We currently have two active projects in the first focus area, social and cultural factors. One of those is the study of Japanese students in our school system in Marysville, Ohio. Another is the study of the African American students in the Saturday Science Academy run at the Clark Atlanta University in Atlanta, Georgia.

The second focus area on public expectations and societal incentives has a number of active projects, most of which concern the question of partnerships with education, with the goal of identifying the common characteristics of successful partnerships and developing guidelines to promote their replication.

The third area, school organization and economic and political forces, concentrates on the effect that curriculum reform has had upon the nature of the schools themselves. Several aspects of this focus area include studies of school restructure. We're also working with the American Association for the Advancement of Sciences Project 2061.

Fourth area, new technologies, there is a research and development effort focusing on computers and telecommunications. Our mission in this area is to determine how technological developments that are currently under way will affect curriculum and the structural reform.

The last of these areas concentrates on the integration of science with other curriculum areas, with specific focus on curriculum integration of math and science. Although we intuitively sense the benefits of an integrated curriculum, the research base is quite small in this area, so our focus is to conduct research which will facilitate the development, implementation, and evaluation of integrated teaching and learning of science and mathematics.

Our overall mission, then, is research which will benefit the reform efforts. The underlying philosophy of the Center is that science educators alone should not and indeed cannot define science education. Science learning and research must be a product of a di-

verse group of individuals, including educators, scientists, researchers, policy makers, business and community leaders, and students. In accordance with this philosophy, the Center encourages the participation of and promotes discourse among individuals from these groups.

It is my firm belief that research is crucial to the success of those reform efforts and the success of tomorrow's schools. In order to be successful, educational reform must be based on what we know about how we teach and learn and about change itself as it takes place in our classrooms. This knowledge can come only from well developed and thorough research efforts. Current reform efforts are an attempt to solve problems which the reform efforts of the 1920s and 1960s attempted to solve. The concern is that 25 years from now we will be facing a situation where we are lamenting the failure of the educational reform of the 1990s.

Although our current reform efforts pay greater attention to findings and researchers, they are still not excessively based on research. Education research infrastructure is far too small. To meet the demands that have been created by this current wave of reform, we need a much expanded infrastructure. For example, the entire science education research community generates somewhere in the neighborhood of 500 research manuscripts in a year. But when we look at just one of five primary journals in biochemistry, we find over 1,400 articles annually.

Post-doctoral positions are an example of the difference between the scientific community and the education community when they think about research. Funding for post-doctoral positions are the norm for scientific research to the tune of millions of dollars a year.

In contrast, the post-doctoral position is almost unheard of in educational research. There is little or no funding on the Federal or any other level. We graduate individuals professionally prepared to conduct research, and immediately we put them into positions where they have responsibilities for teacher education, preparing teachers, with little or no time to follow up those research questions that they are on the edge of when they finish their dissertation. We need that time for them to continue in-depth the studies they have started and to broaden those into other disciplines just as appropriate.

We will have two few researchers, too little research, and reform efforts which have failed to make a significant difference if we don't deal with this manpower problem insofar as professional education research people are concerned.

There are a number of things that can be done to expand the research base, give it greater coherence, and bridge the gap between research and practice. I would like to offer to the Committee several examples drawn from the Center's recent activities, including development of a national research agenda for science education, the concept of action research, and our research efforts concerning partnerships.

First of all, developing a national research agenda for science education. To this end, the Center has been instrumental in the formation of the Science Education Research Agenda Coalition, SERAC. SERAC has identified the following goals: Articulation of

the parameters for science education research; informing and actively involving both researchers and practitioners in science education research; developing effective means for the infusion of science education research enterprise and science education research findings into science teacher education preparation, pre-service, and enhancement or in-service programs; and finally, developing the professional posture of science education and enhancing the public perception of science education, science teachers, and science teacher education.

We propose the involvement of teachers in research through what we call action research. At its simplest, action research means involving teachers as integral components of the research team. Beyond that, it means treating teachers as professionals in a challenging and increasingly complex profession, one that requires advanced skills, the ability to meet daily challenges, and the ability to think introspectively about one's work. If through action research we can provide teachers the basic research skills they need to examine their own work, we will have significantly bridged the researcher/practicioner gap and added significantly to the research base.

Revitalization of teachers' self-concept as they engage in reflective inquiry has been a major outcome. We find in action research programs that we've conducted in the State of Ohio that the confidence, the feeling of worth, and the professional behavior of teachers changes immensely when you give them a chance, the time and skills and resources to reflect on what it is they're doing, how it's working, and what they can do to change it so it works better.

Partnerships between teachers and scientists or business industry personnel can also serve to raise the professional status of the teacher, provided that partnerships are maintained on the basis of equality and shared responsibility between teacher and partner. The greatest advantage in such relationships may lie not with the outside resources per se or with the curriculum which is produced, but with the changes in teachers' perceptions of themselves and with the changes that the schools make—in terms of restructuring school schedules, for example—to accommodate the suggestions of newly professionalized and revitalized teachers.

I thank the Committee for this invitation to appear here today. I firmly believe that current reform efforts offer the promise for a greatly improved school system, both here in the State of Ohio and nationwide. I also believe that reform's chances for success will be greatly improved if we continue to emphasize the importance of the dialogue between research and reform. The National Science Center for Teaching and Learning is looking for answers which will be of help to students, teachers, parents and policy makers as we struggle to improve our schools. I and my fellow researchers stand ready to work with you on this issue which is of great importance to our nation's future.

Thank you.

Chairman GLENN. Thank you very much, Dr. White.

The next witness, Dr. Sammie Campbell Parrish, is the new Superintendent of Cleveland Schools.

Dr. Parrish, I understand you joined the Cleveland School staff officially on July 1st. With the Fourth of July holiday weekend in

between, you've had at least two or three days to get your feet on the ground.

TESTIMONY OF SAMMIE CAMPBELL PARRISH, SUPERINTENDENT, CLEVELAND PUBLIC SCHOOLS

Dr. PARRISH. I should definitely have all the cures by now.

Senator Glenn, I, too, appreciate the opportunity to be here this morning. As you said, having joined Cleveland Public Schools just a few days ago, my remarks will take a little different turn. My comments will be centered on reform from a more national perspective and how I think that will probably make some sense for Cleveland Public Schools.

I have been in the curriculum area in four different states and have followed rather closely what's happened to reform in general, and in math and science. I initially decided to focus my remarks on what has worked in my experience in terms of curriculum reform in the past. And as I began to reflect on that, I realized that there's not a lot of success to reflect upon. In short, school reform and curriculum reform don't have a very good track record in this country. And I suppose what we have learned is mainly what we can glean from our failures in school reform. Certainly there are principles that have emerged from some successful pilot projects, some in states and some in local school systems and some in classrooms. I think we can benefit by these. But I think our best source for planning school reform that will be long-lasting and comprehensive will be to reflect upon our failures and to avoid repeating those failures. As Dr. White just mentioned, we certainly don't want 10 years from now or 20 years from now to be lamenting the failures of the school reform of the 1990s and even into 2000.

I think school reform is an unhappy state of affairs. It is imperative that we approach math and science education reform in this country in a radically different way than we've approached it in the past, recognizing more clearly the roots of our problem and maybe digging out those roots and planting new seeds that have some chance of blossoming or growing into the kind of mathematics and science literacy that we're seeking.

One of the other speakers mentioned that we have no black box, and another said that we need more research. I couldn't agree more. We have some evidence right now, some research right now, limited as it is, which still hasn't made its way to the classroom. So that's a place to begin.

When I think of national reform, my worst fear is that we as a nation won't have the patience to do what we need to do; that we won't have the patience to do the research; and we won't have the patience to engage in the kind of long-range approach and thinking that will be necessary to bring about long-lasting reforms. We tend to think as a nation that 10 or 15 years is too long, and this urgency of a quick fix takes over. But I guarantee you that if we were in the year 2008 and we were emerging as a leader in science and math that our entire nation would be proud of that.

So I would urge those of you in Washington who are looking at this from a national perspective to realize that as a nation we need

to be deliberate and comprehensive and reasoned in our approach to math and science.

Now, we need a two-pronged approach. Certainly those of us in local school systems, local superintendents and teachers, even states, must not sit around and wait while Washington does that or while this research is completed. There are things we can do right now. We can continue efforts such as those that have already begun in Ohio and in other states. I plan to begin immediately in the Cleveland Public Schools. There are changes, there are principles that can be applied right now in classrooms and in schools, and we need to go about doing that.

In terms of recommendations for statewide and nationwide reform in math and science, I would offer the following from a non-mathematician and non-scientist's point of view, but from a generalist's point of view, having observed what's happened in teaching and learning in the classroom for many years.

First of all, we must face this curriculum squeeze issue head on. There is a problem of too much in the curriculum and not enough time to teach things well. This doesn't have to be. We design that curriculum. We develop that curriculum. It can be what we want it to be. And it should be what we believe it should be. We must be selective. We must determine what is of value to teach and what is of value to learn. And we must not spend time doing anything else. We must resist the attempts of special interests to put everything and all of their special topics in the curriculum and instead focus on what is important for students to know and be able to do, the concepts and ideas that are significant enough for us to teach and reteach in all possible combinations until students can apply them and use them to solve problems and create new knowledge.

Second, we must, especially in the early years, focus our attention on the area of mathematics and science, on tapping into the natural curiosity and inquisitiveness and inventiveness of very young minds. We must resist the urge to think that if we put a bunch of facts on pages of textbooks and give them to students early enough that somehow we will be ahead. I contend that we will remain behind if we take that approach. Instead, it may be better if we do nothing in the early years but focus on encouraging habits of thinking, habits of problem-solving. And in the natural environment in which students find themselves, there is plenty of room to teach mathematics and science concepts in ways that youngsters will remember them. By the time they get to the middle elementary and upper elementary and into junior high, they will be such masters at problem-solving and thinking that it will take them only a matter of days to master many of these simple facts that we spend years teaching them when they are younger. Because by then, they will understand how essential these facts are in the problem-solving that they will want to do, that they will be compelled to do because they have developed these habits.

Third, instructional practice in the classroom must be active and not passive. We've heard this many times before. There is nothing new about it. But I challenge you to find any study done anywhere in the last 50 years to tell you that's what's happening in classrooms. Instead, the studies generally say in most cases it is the opposite, that it is passive learning and teacher talk, even in situa-

tions which would naturally be laboratory situations, such as science and mathematics.

Fourth, I think that there are other conditions of teaching that enter here as well. Dr. White referred to our past history of not treating teachers as professionals and collaborators and involving them in this process. We must do that. We must provide teachers with proper facilities and materials, time to plan, time to assess. Certainly, we must push teachers to be more accountable for student learning and for student outcomes. And I will be doing that. But people like myself must be held accountable for providing the kind of conditions in which teachers can be successful. They cannot be reasonably expected to be successful or accountable if we, as administrators, citizens, and others, do not provide the conditions in which that is likely to happen.

My fifth point is that mathematics and science assessment as used today are willfully inadequate in my estimation. I believe in assessment. I believe that we must assess only what's of value, and we must assess it in multiple ways and in new ways. Assessments can be constructed that serve to bring about the kind of change that we want to see in classrooms, that we have been unsuccessful at in the past, if we approach it from a different way. Teachers want to see results from their efforts. They don't want to teach their hearts out all day and get dismal results such as we've just received in Cleveland. So if we construct the kind of assessments that can drive that kind of teaching, I think we will be further ahead.

Sixth, excellence and equal access are not at odds. There are those who would have us believe that if we set higher standards in science and mathematics, not all of our students could meet those standards. I can say that those two things can very nicely go hand in hand if we approach it the right way. We must convey that all students can learn and are capable of learning at high levels. We don't convey this when we track students into low level math classes. We don't convey this notion when we have courses available in rich suburbs that are not available in other schools. We send, instead, a message to our students that somehow they are not capable or they are not deserving.

My seventh point: Yes, we do need more time for science and math instruction. Yes, we need our students to take more courses in those areas for graduation and beyond. But our most serious problem is one of quality. Quality of what we are teaching and how we are teaching it and how we are assessing it. Parental support is another thing that comes to my mind when we talk of this. We don't have a lot of parents who are greatly accomplished in math and science for our students to go home to and engage in dialogue with, but I think there are steps we can take in this regard as well.

We can attempt to help parents to understand and believe that their children are capable. Many parents, especially parents of poor youngsters, would never dream that their students and their children have the capabilities to pursue higher level math and science when, indeed, they do. We must convince these parents, because they are the significant others in the lives of these children. We hear a lot of talk about raising teacher expectations for students, and we must do that, but I think parents convey subtle mes-

sages all the time. I would not lay out an ambitious and unreasonable agenda for parents, but I do think that we can convince them of their children's capabilities, that we can help point out to them that it is effort, or lack thereof, more than ability, or lack thereof, that prevents our students from accomplishing what they must accomplish. We can help them to see the connection between the time and effort that their children put in and their results. We can find ways for the hands-on approaches in science and mathematics to spill over into the home in homework assignments and general activities.

I'd like to see students in this nation not see such a clear distinction between what is school work and what is fun. Somehow our students seem to think that school work is something that is work, and how they spend their leisure time is something that is entirely different. I think that students in other countries, especially some of the Asian countries, don't see that clear distinction. And they actually can get together in study groups to have fun and to learn at the same time. This is a concept we can promote.

In closing, as Superintendent of the Cleveland Public Schools, I will in very short order become familiar with what is happening in the State of Ohio and what is happening especially in the Cleveland Public Schools. I'll become familiar with the strengths, our strengths—I know there are some—as well as our weaknesses. I'm aware of our performance on the Ohio Proficiency Tests, and I'm aware that we are not proud of that. But I'm also aware that it will not remain as it is. So I am not deterred, but encouraged, encouraged by the responsiveness of the people I've met in Cleveland so far in wanting to address these problems. So I'll begin immediately to build on these strengths and will not hesitate to rid the system of practices and programs that are not working and that are not producing the results that we want. I will not hesitate to redirect resources into the curriculum and instruction area in a very targeted fashion.

Collaboration will be a cornerstone of everything we do under my leadership. This collaboration will be focused, not just collaboration for collaboration's sake so that we can say we've done it, but rather that we can attain our goals. It will take the efforts and commitment of the broader community. And if we are to make these dramatic improvements—and I believe we will—I have a good start in terms of advice. The students wrote me letters last month. They've appeared in the paper. I have a lot of advice from students, and needless to say, much of it is very good.

Someone referred earlier to the bureaucratic inertia and decay that exists sometimes and prevents projects such as the ones that have been discussed here today from happening. And that also will be at the top of my agenda, to reduce that inertia and to push the bureaucracy out of the way so that our good teachers and good researchers and collaborators can make things happen.

Thank you very much for this opportunity this early on to give some of my thoughts on this issue.

Chairman GLENN. Thank you, Dr. Parrish, very much. And we appreciate your willingness to be here on short notice and just after you took over.

Let me swing a little broader loop here maybe than just the specifics that we're talking about and take off on Dr. Parrish's comments about parental support. I ask this because I wonder how much Project Discovery, teacher training, and research in that area will do as another factor in regard to some of the bigger societal changes that we have that have occurred over the past 20 years or so in this country.

I'm thinking of things like half the marriages end up in divorce. I saw a figure one day that approximately 54 percent of the kids under 12 are in single-parent homes. Don't hold me to that. I haven't checked that figure out. But, even if that figure is off, it's still an enormous figure. And kids tend to rise to the expectations of parents or teachers or someone who inspires them. If they're out of school at 2:30 P.M. and Mom or Dad isn't home in a single-parent family until 6:00 or 6:30 P.M., and they're tired and perhaps studies don't get the attention that they should get. Perhaps the child is not motivated from the home. We're having a long period where children are out of school in the afternoon. I'm just wondering where our emphasis should be. One of the studies that I saw on Asian-American families, a big difference was the expectation of the family. There was a concentration on what was expected. Children rose to that expectation. Is that one of the major problems and are we looking into that area? Or is that something that is just societal and not that directly connected with education? Dr. Hairston, would you start off for us on that? Are societal pressures a major factor, and are we looking into its impact?

Dr. HAIRSTON. My sense is that certainly all of the teachers who are engaged in Project Discovery are keenly aware of the broader external factors which their students deal with every day. Many schools systems in Ohio certainly have encouraged after school programming for that very reason. There are a lot of so-called latchkey programs in which students remain in the school setting with an opportunity to do work that may be academic or may not be academic, but they are in a supervised setting and have a bridge from the formal school day into their lives at home. But it really does bring into focus, in my view, how we structure the whole learning environment and what schools ought to look like for the future. I think that's the larger question.

Our schools are modeled primarily on a model that worked very well 100 years ago when families were structured differently. Our school year being a nine-month year and students being out in the summer all bespeaks a time when children needed to be free to do work in the fields with their parents. And we have lots of people who question the wisdom of all that today. And I don't know if Dr. White's research is looking into structure of the school environment. We know other states have experimented with different types of school years. But I think we ought to be open to all those questions. Our families, our world is simply different than it was 100 years ago, different than it was 50 years ago. And if what we are trying to do is to provide a system in which children can achieve, we ought to look at all parts of how that system works.

A few weeks ago, I had the great fortune of hearing Dr. Edward Demming speaking on total quality management and the issue of how systems influence what you're able to achieve. And it just

really influenced my thinking a great deal. And the question of how we provide the crucible for success is one that I think is before us. So while Project Discovery may not be focused on that directly, it certainly seems to me that the research issues connected around it ought to be.

Senator GLENN. Dr. Wilson?

Dr. WILSON. Yes. The big problem in dealing with issues such as you raise, as you say, the parents, is most teachers find themselves alone in trying to face those issues. They are not able to get help from fellow teachers. They are not able to get help from the central administration. And they have no way of knowing that there are programs like Success For All, like the School Development Program, which have developed over many years of developing expertise to try to deal with those problems. Teachers are not able to get training in school, in college, or in the world of teaching in how to deal with these questions. And meanwhile, in exemplary schools, which have had the time and the financing to develop the expertise to deal with these problems, this expertise is now encoded in things like this manual, which I waved to you before, which answers, Senator Glenn, many of your concerns about how you involve parents in a very practical way in the operations of a school, how you bring parents to school to listen to children as they show how well they can read, how you get ahold of parents so that they make sure their children come to school and on time. This manual has specific procedures for how the teachers get a hold of parents whose children arrive even just 15 minutes late to school. This manual has the procedures by which you address health problems, especially the problems of seeing and hearing, as soon as they appear and are recognized rather than hold children back because they're not normal. But it took many dollars and many years of experience to build this manual. This is not something that a single teacher can do by herself.

And, I mean, Robert Slavin, who is responsible for this program and for this manual, told me that this is just the beginning five years of his program. He needs 50 years to build all the expertise that is needed to take those children to the point of meeting the National goal. But we have to support those programs so they can build this expertise, and then programs like Discovery, you have to have access to the results of those programs so that we can help the teachers. And we have to have professional development programs which enable teachers to gain this expertise themselves. And we must have restructuring programs, which enable teachers to collaborate, to meet the problems the children have outside of school instead of having to face them alone.

Chairman GLENN. You mentioned a Baltimore school where, even though I gather the students are in a disadvantaged area, they have been able to create an environment there even with these disadvantaged kids that's exciting. They're excelling; they're doing great. What's the difference? What's the key element there? Is it the teachers that make it exciting? Or is it that they reached out and did the parental involvement like you're talking about here? What was the key difference in that area? Because that can be a model for all the rest of us, if it really works.

Dr. WILSON. The key element is that there is a research team at the Center for—I haven't the exact title, the Center for Schools for Disadvantaged Children, which is funded by the U.S. Department of Education, lead by Robert Slavin. And they were able to work with the teachers in a number of schools—I think they started with five schools. And they had the resources so that they could work with the teachers so that they could build the expertise jointly with the teachers to address the problems.

First of all, they helped the teachers to build a collaborative culture in the school together with the principal, the teachers. They have goals. That's the title for Success For All is the goal for the school. You will find most schools don't have goals like that. And the principal and the teachers work together, working with the students and the parents to achieve those goals. That's common to all the successful restructuring programs, not just Success For All. And what is missing from those programs, you have to understand that what is missing is that collaboration which gets them to get control of the problems, get the students excited, get the students eager to come to school. What is missing is the time for continuous professional development of those teachers so that they can build more and more expertise, not just in how to get the children excited, but how to get them into real challenging subject matter.

We are giving six-week summer workshops to teachers, but only to a small number of teachers because that's all we can afford. And we shouldn't be just having them for one summer. They should have ongoing professional development every week, three or four hours every week, and of a quality that they have never seen in most schools because most of the professional development that is presently available is a joke, especially when compared to what's available in Japan.

Chairman GLENN. Dr. White, do the societal factors play here as opposed to expertise of the teacher? Is there a situation where you might have the most expert teaching in the world and all the research done and everything perfect and it still not work very well because the student isn't motivated because of lack of parental involvement and so on? Is that a possibility?

Dr. WHITE. That's very much a possibility when you talk about single-parent households or maybe even grandparent household or whatever.

Chairman GLENN. Along that line, about two or three months ago, the Sunday *New York Times* had an article you may have seen on the front page concerning Oakland, California schools, where over half the kids in one of the schools lived with no parents. They were in foster homes or living with a relative, and they were passed around from one home to the other.

Dr. WHITE. We haven't approached the problem by trying to do something about divorce. But other than that, looking at other support systems for children is part of what we are involved in. For instance, there's a 4-H program, which is a major national effort. I grew up on a farm, and I was a 4-H Club member, but I didn't realize the extent to which it had gone into urban communities. And it is possible to pick up an activity that young children would be involved in out of school.

What we haven't probably done is looked at ways of connecting that to classroom activity. The Saturday academies are the things we're looking at in Clark Atlanta. There's an awful lot going on in terms of role models. They're in a program there that is structured like a school. They have classroom activity, but they don't grade them. They don't take tests, and they don't grade them. So there's a lot different feeling there. The kids are in it because they want to be there. They're trying to learn things. But yet they're putting them in a school situation to try to make it a successful experience in a classroom environment so that it will perhaps translate to the school system.

I think looking at Scouts, looking at buddy systems, where young children are working with other young children, one is older, maybe a sixth grader with a third grader, there's something to be learned from that because any buddy system I've ever seen probably is very, very good. And probably the older buddy learns more than the younger, but they both benefit a great deal. Maybe there's ways to build role models, to have buddy systems for teachers, buddy systems for partnerships, all kinds of ways in which that might be a conventional benefit that we haven't explored.

I think having the children and the parents involved together in the activity that is science or math-related is another way of drawing in situations where there are parents, but they're not comfortable with the content, in activities with their children. That's done at the community programs, some church sponsored, some community center type things. So yes, we are looking at connecting these kind of out-of sch-ool experiences in a way of sort of establishing some other support system for children. If the parental support isn't there, then either trying to build it with the parent structure that's there or to develop other support systems that maybe are not parental folks. We're looking at it.

Chairman GLENN. Dr. Parrish, are we asking our schools to take over a lot of society's forming influences that used to be in the family?

Dr. PARRISH. I think we are. Your initial question, Senator Glenn, was does the collapse of the family, or the family as we once knew it, have an impact on education? Absolutely. Yes, it does. But I'm not sure we have the wherewithal to turn that around. So I would caution us against devoting too much attention to that particular variable. As we approach school improvement, there is a whole list of variables that relate to how well students achieve in school. Some of them are alterable by the school, and some of them aren't. For example, two that are very closely related to student achievement which we can't alter at all are how much money parents make and how much education parents have. At least we can alter it very little. So it's always a tough question to answer, but we have to begin by admitting that societal factors have had a tremendous impact. But then we have to look realistically at which ones we, as school people and communities, can alter.

I think parental involvement is in that gray area. While it's not totally within the control of schools, we can do some things to try to alter it. Some have been mentioned: the whole notion of community education, of having the school not just be that isolated building, but involving schools in taking on a lot more, including educat-

ing parents, opening school buildings, just making education a total community responsibility. If the intact family is not there and the school can't handle it alone, then we as a community have to consider our responsibility to educate our children.

There are some examples. We're looking, I guess, at the Comer model from Dr. Comer at Yale involving family, involving parents. But again, I think we have to be careful with that issue because we don't want it to be an excuse for lack of progress on the part of public schools.

Chairman GLENN. There was a study I saw not long ago that I believe was done at the University of California at Berkeley where they had different racial minority groups that they studied at the university. Students came in with approximately the same background. Yet, once they were having problems in school, there was a difference in the way that they approached how to cope. It went back into some minority groups where apparently the emphasis is on the student. Do it on your own, you know, you can do it yourself. Alone. When those students ran into problems at the academic level, they tended to not want to join with other people. They wanted to do it on their own. That's the way they had been brought up.

The group that did not do that were the Asian-American students, who, as soon as they had a problem, they banded together, three or four of them got together as a group. They would work together and work through their problems. It was almost a replacement for the family, even though they were away at college. It was once again the societal influence of how we're brought up and are we willing to really use a replacement for the family? Or is the school going to have to, of necessity, be almost a replacement for what used to be the expectation levels that the family provided.

We can move on to some other areas. Do you think we're far enough along yet to say that assessment and testing for students and teachers should be required at the National level? Should we enact national standards? I know it would have to be a goal initially, but is it something for the future of this country that we have to do eventually?

Dr. HAIRSTON. Senator, if I may comment, in all the testing, there often is the risk that the testing does several things. It moves to the lowest common denominator. It removes the diversity that is a great strength of the educational system in this country. It is an easy answer, a quick fix to the discontent that is among all of us as we want to achieve even better outcomes for our students. I worry that those risks will simply mask the real kinds of change that need to occur if, in fact, we really want to improve what goes on in the learning environment. The more that we turn toward affixing a sense of where the thing went wrong and to look at that as a matter of placing blame on where it went wrong, rather than engendering a feeling that we all need to work together to try to find these solutions, takes us down the wrong path in my view.

Chairman GLENN. But how do you have accountability in school systems unless you have some sort of accomplishment standard that you measure in some way? Otherwise, you really go to the lowest common denominator. Nobody feels they have to shape up for any reason at all.

Dr. HAIRSTON. I think you can do that with the individual progress of students and the expectations of what kinds of learning capacity that you want to have in the individual child. And that, as an answer to me, is a far more realistic answer than, "We will have for our teachers a certain kind of testing that they will achieve at."

Chairman GLENN. Anyone else care to comment on that?

Dr. WILSON. I mentioned the need for a black box. We have to understand what has failed in our education system, and we have to be able to get to the root causes of failure. And it is clear that over the last 30 years, as Dr. Parrish has said, we have more failure than success in reform, which clearly indicates we have not found the root causes that we need to address. But in my readings, to try to understand myself what is known about the education system and this problem, it became clear that direct classroom observations obtained by responsible researchers are far more informative than all of our tests. Things like John Goodlad's book called *A Place Called School*, which is based on a tremendous effort, actually going into the classrooms and recording what's going on and commenting and organizing what has been observed, taught me a lot more than reading all the test results.

And one thing that we are very much missing at the present time is an independent evaluation structure which can carry out these kinds of classroom observations, and not just in the average classroom as John Goodlad did, but in the exemplary classrooms like the Success For All Program, and tell us what is good and what is bad about the reforms, advise us on where reforms could be really helpful if we put more money into them so they could do things properly, help them to make their expertise available to other schools.

I have watched Reading Recovery, which does make expertise available in other schools, but it is operating on a shoestring because there is no support for the kind of diffusion of knowledge that they are providing. The Reading Recovery teachers are working overtime, double overtime, because of the lack of support for actually taking expertise from one school to another. So I would plead with you that we change from assessment to evaluation, from tests to observing what's going on in the classroom, and then coaching the teachers, coaching the way our tennis stars and basketball stars are coached every day, so that when things go wrong in the classroom, they are helped to correct it.

Chairman GLENN. I wish they had the money they get to put in the school systems. That might help a little bit, too.

But let's say you're a businessman and you're going to employ X number of people. You have certain qualifications, and you require a high school diploma. A high school diploma from one part of the country or from the poorest school district in Ohio or any other state compared to the high school diploma from the best school district from that particular state or across the country are completely different pieces of paper as far as its meaning goes. You may have to give this person all sorts of remedial education to even put him to work in your shop. So the certificate means very little anymore. I don't think it means as much as when I was in high school, for instance. I think there was much more of a standard accept-

ance of certain norms then, and there was a family—I keep coming back to the family—expectation. I think things were not as different from one school to another as they are now.

If you don't have testing, what kind of a standard can a businessman expect if he sets out to hire people and has—what we have basically across the country is, as pointed out in that book, *Head To Head,* that I mentioned earlier. We have 15,000 school boards in this country all elected on the basis that "We won't raise your property taxes." Now, where do we go with it from there? Do we have to go in with a huge infusion of Federal money or state money or equalizing funds?

It's a very tough situation. We're the only industrialized nation in the world that does not have a national education system. And before I get misquoted, I'm not proposing we move all the school boards out nor go to a national education system. Somehow, we have to have standards that mean something if our education system in this country is to be accepted across the board, it seems to me.

Dr. WILSON. I absolutely agree with you, Senator, but what I am saying is, if I am a businessman, if I am looking to hire somebody, typically what I will do is give that person a test and see whether the person can actually perform the test.

I will not give him a test if I am a sensible businessman. I mean, if that person has to be a receptionist, I will want to watch that person for a day being a receptionist. Can they take the telephone calls? Can they get the messages to the proper person? I'm not going to know that by whether they passed a certain standardized test. So I'm going to be more interested in looking at a school from where they came to see the reports of what was going on in the classrooms. If those kids were staring out the window all day, I know that that diploma is worthless. If I see a report that they were engaged, and they were forced to think, and they were forced to show leadership skills in the classroom, and the classroom reports show that, I don't care what they did on the test. I know I'm getting a good student.

Chairman GLENN. Dr. White, you're hoping I'll pass you by there? Do you favor testing and establishing standards, or do you favor the approach that Dr. Wilson has talked about here?

Dr. WHITE. I guess the idea of standards is important. I think it's something we need to deal with. In my own mind, I wonder if there's a set of standards that would help us understand what we consider to be quality education, but that there might be some way of selecting from those standards in individual schools and communities based on those school and community needs and values.

Same sort of thing with assessment. Can there be ways of assessing that are considered quality? And then from those, school systems would be able to draw from those the evidence that they feel reflects and indicates what it is they value as outcomes from education. I don't know if that will work.

The National Board of Professional Teaching Standards is an example that is sort of like that, at least so far. And that is that they have put together, through representation from any and every category you might think of that represents education, a set of teaching standards and ways of assessing that, and then to nationally

certify teachers based on that board's findings and the assessment material. But that national certification isn't something that's required at this point. It isn't something that becomes law at this point. It's something that teachers individually, as well as stool districts, might buy into if they think it's going to be of value for them to refer to those and reflect on those. Of course, the worry turns around, comes back and says, now, will that become the bible? Will that become the law? Will that become what everybody has to do to be certified? And that has some positives and has a lot of negatives. So it's a tough one for me. I like the idea of having a standard, but I'm not sure that we all have to meet every letter of that standard, because not all of our school conditional situations——

Chairman GLENN. If you set standards, then you get into the other issue that is difficult and that is, do you require re-certification testing of teachers on a regular basis?

Dr. Parrish, what do you think about testing and standards?

Dr. PARRISH. I'm not certain, Senator, that I've sorted it all out in my own mind, and neither have those people on the various commissions. I read almost weekly about their conflicts and contradictions, and I tend to favor national standards but not national testing. And that's just some preliminary thinking on my part. In other words, I can't help but believe that the document developed by the National Council of Teachers of Mathematics is a good, solid document.

Chairman GLENN. I know we didn't come to debate this, and I sound as though I'm on one side of this, and I'm not. We're just looking for information. How do you set standards and know they're being met without some form of testing?

Dr. PARRISH. I didn't say that people in Washington——

Chairman GLENN. Let's say in Cleveland.

Dr. PARRISH. All right. I can tell you exactly. We have the document that I have just referred to. The standards that the National Council of Teachers of Mathematics developed is available. It's been widely disseminated. It gives us a picture of what excellence looks like. Some people don't even know what excellence looks like. They think excellence is down here when it's really here. (Indicating.) Or they don't know how to articulate that or how to even put that down on paper in a way that teachers can understand.

So I think there is value in having national standards which everyone, those in local school systems, can look at and compare what they're doing with those standards. There were many local people, people from many states and local school systems that helped to develop those standards, and I certainly would not go off in a corner and develop a mathematics curriculum in the Cleveland Public Schools that wasn't based on those standards.

Now, that doesn't mean that I am ready for someone to mandate a test and then, you know, send it out and we start all of that rigmarole. But I think standards are valuable, and I don't think you necessarily take the next step of a national test. And right now, I would not be in favor of that.

Chairman GLENN. Let me ask one other question, and we are going to have to move along. We have two more panels yet to go.

But let me ask one other thing. With all this past human experience, the summary of it or the distillation of it that we call education, are we going to be able to stuff all this past experience into little heads without going to longer school days and to longer school years?

In this country, I think our kids average about 180 days a year. In Europe, it's 215 to 220. I think Japan is 240, and Korea is maybe 250, I believe it is. I think those are approximately the current figures. Correct me if I am wrong. You're the experts. But I think that's about right. And they go longer school days. They're not out of school at 2:30 P.M.. They're going to about 4:00 P.M. or something like that. Are we going to have to go to better use of our capital property—capital in education means the school plant—and not have it sit out three months out of the year and only be used part of each day? How do we do that, Dr. Hairston? Are we going to have to go to longer school days and longer school years? That's the basic question.

Dr. HAIRSTON. Senator, I'm going to play on your word "capital." I'm interested not only as much in the physical plant as in the capital head. And it seems to me that when we ask ourselves what kind of structures will support our goals if our goals are, in fact, to have students who are first in the world in mathematics and science by the year 2000, what do we have to do to do that? And we know that our failures, as Dr. Parrish has outlined, I think very eloquently, tell us that this current structure may not be working for the world in which we live today, and I alluded to that earlier. I think our real challenge is to find the structures that will help engage our teachers to their creative heights, to their intellectual heights, and who will pull children into that intellectual community that they create. How do we help them do that is our real challenge.

Chairman GLENN. Dr. Wilson, what do you think? Should we have longer school days and more numbers of days in the year? Are we going to have to go that route?

Dr. WILSON. Not necessarily. I agree with Dr. Parrish's comment that what really counts is the quality of the teaching and learning that takes place and that we don't get up the quality of teaching and learning with longer school days. And more school year will do our children no good whatsoever. And, in fact, I believe we need to be sending children home early maybe one day a week so that the teachers have a chance to work with each other and to gain professional development. Through professional development, they will gain the expertise that they need to raise the quality of what goes on in the classroom.

And I would point out to you a widely read book now by Stevenson and Stigler called *The Learning Gap* that points out that Japanese teachers and Taiwanese teachers and mainland Chinese teachers spend only three to four hours in the classroom, where our teachers have to spend five or six. But they learn through professional development that provides quality of instruction in those hours that we cannot match with our daily schedule of teaching. Our teachers go home exhausted at 2:30, so they cannot stay until 4:30 to do a longer school day. And I believe we will be better off to shorten the number of hours that students spend in class in order

to get up the quality of instruction in those classes. And until we address that problem, to talk about a longer school day is not going to do us any good. In fact, it will take us in the wrong direction because it will divert scarce resources from addressing the quality issue.

Chairman GLENN. Dr. White? Should we have longer school days and years?

Dr. WHITE. I couldn't agree more with Dr. Wilson. Maybe using facilities more and the buildings open more, but not for each student. We have smaller groups, more hands on, give teachers time for reflection, give them time and energy to act as the professionals that they're trained to be. We might even give them a telephone in their classroom or in their office, which many of them do not have, to carry out this connection of what they do in the classroom with what is happening in the real world. Can you imagine doing your work without a telephone that you are close enough to that you can hook to a modem? You can tap into the library, you can network with another teacher in another state somewhere. We don't give them a chance.

I think if we gave them smaller classes, more time to be professionals, we might solve an awful lot of problems. And if they are involved, they have the skills and get involved in inquiring into how their teaching is going, how it's working for their kids, we might get a lot more for our bucks, a lot more for our time than all the curriculum revision that we can engage in.

Chairman GLENN. Dr. Parrish, can Cleveland look forward to a 220-day year?

Dr. PARRISH. Certainly not next year. I wouldn't be as quick as my colleagues on the panel to totally dismiss altering time as a variable. I think probably we need to alter time for some and maybe not for others. I don't know that everybody needs a 200-day school year, but we've got to say that if all students, regardless of their deficits or regardless of their current achievement level, are going to attain these same high standards, common sense says that time may be one of those variables that we have to alter for some and not for others. In other words, there are year-round education models with sessions where some students stay for smaller class sizes and extra instruction so that they don't fall behind. So I wouldn't dismiss it, nor would I hurriedly go to that as a solution.

Chairman GLENN. We've all mentioned the money involved in this, and that's something we have to grapple with, also. We don't have time to really get into a discussion of all this, but if you go back into the colonial days of this country when our school systems were being formed, probably anybody that had real wealth had it mainly in property, and they were more able to pay than anybody else. And yet now we're two-thirds service economy, and yet we're still looking to the property as the base for our school system. It doesn't make any sense at all. Try and alter that one.

We have a revolution in California where they had an excellent school independently some years ago, and Proposition 13, as it was called out there, came along and pretty much put their school system into demise, I guess. And so that's a whole other level here. When we have to have more equalizing funds come from the Federal level, the Federal Government is broke, of course, as everybody

knows right now. So we haven't even gotten into a discussion of money yet.

We are going to have to move along. We need four days of hearings instead of three hours, I guess.

Very good, very interesting this morning. Thank you very much.

Chairman GLENN. We look forward to our next panel, "Selected Ohio Programs for Science and Mathematics Education Reform." Our first speaker James Porter, who is Superintendent of Lake County Schools. He administers a model science center of hands-on science for all third and fourth graders from Lake and Geauga Counties. I believe he has a 1½-minute video of his science center that we can look at first this morning.

Also, I want to add, Dr. Michael Salkind is President of the Ohio Aerospace Institute, just a short distance from where we are right now. OAI hosts numerous education engineering programs. It links students and teachers with the NASA Lewis Research Center here and with Wright Patterson Air Force Base.

Ms. Renee Kent accompanies Dr. Salkind as a graduate student at the University of Dayton. Through funding from OAI and NASA, Ms. Kent performed engineering research at NASA Lewis Research Center here.

Also accompanying Dr. Salkind is Mrs. Sue Zepp, a school teacher at Woodridge Elementary School in Summit County. Through assistance from OAI, Mrs. Zepp adopted new model curriculum for third grade students. So we welcome you this morning.

Dr. Porter, I believe you want to lead off with a little video, right?

TESTIMONY OF JAMES PORTER,[1] SUPERINTENDENT, LAKE COUNTY SCHOOLS

Dr. PORTER. Almost that. Imagine a center for science and math that serves all elementary students, has strong in-service programs for teachers, receives encouragement, support, and guidance from business and the industrial community, taps the expertise of area colleges and universities. This brief video that you have mentioned, if our technology permits, may help you with that imagination.

(Videotape played.)

Dr. PORTER. That video goes on for another seven or eight minutes, but we'll talk with you instead. I'm the Superintendent for the Lake County Board of Education and Chairman of the Lake School Superintendents Association, which includes the superintendents of the Local, Exempted Village, City, and Vocational School Districts in Lake County along with the presidents of Lakeland Community College and Lake Erie College. We appreciate the Committee's interest in the area of systemic changes in science and mathematics education for all students and welcome the opportunity to share our experiences with you.

My testimony will focus on four key points. First, creating a bold new approach to elementary science education is seen as imperative. Second, a bit about why this program works. Third, business, industry, higher education, parents, and government as collabora-

[1] The prepared statement of Dr. Porter appears on page 136.

tors with the school districts. And finally, the Lakeland Area Center for Science and Mathematics as a systemic change model, at least potentially that.

First, the superintendents in collaboration with Lakeland Community College and the businesses, Ohio State Representative Dan Troy—whose picture graced the video there—and the Ohio Department of Education created this bold, new approach to elementary science education as a way to make science interesting and exciting for all students, everybody. We all agree that it is vital for young people to get hooked on science and math at an early age. That's not too difficult. Kids are natural born scientists.

But with limited equipment, individual schools have difficulty finding the time or resources to offer real hands-on science experiments that keep kids interested and challenged. Often, their teachers, who are highly skilled in reading instruction, lack the background and confidence needed to make science and mathematics a great adventure. Regular elementary classrooms are not set up for science either. Lack of utilities, equipment makes it impossible to sustain high quality, hands-on programs in a regular classroom. Since individual schools and districts could not go it alone, and since time is running out in the race to the year 2000, the superintendents decided to act as a group to create the Lakeland Area Center for Science and Math.

So our second point, why does this program work? The program is not a field trip. Not an assembly. Not a museum. It's a well coordinated series of hands-on, inquiry-based science experiences. And you can see some evidence of that around the room here and some little scientists sitting here, too, as a matter of fact.

Chairman GLENN. Are they going to demonstrate a hands-on science experience for us?

Dr. PORTER. Well, if there's time.

Chairman GLENN. I think we ought to take time for that when you finish.

Dr. PORTER. That's up to you, of course.

Anyway, these experiences involve every third grade student and teacher in every school in Lake County and Geauga County. That's an enrollment of over 47,000 students. They aren't all in third grade, thankfully. So it's a good sized group of schools. Students visit the center one classroom at a time, do hands-on, fun, exciting science experiments three times during the year, using equipment impossible to duplicate in every elementary classroom.

Topics included Measurement/how to be a scientist. That's the further ones over there. Light and sound, which is typified by this oscilloscope. Electricity and magnetism. The circuit board is one of the things that happens there.

Prior—this is really critical too—prior to the visit to the center, an instructor visits each class in their own classroom to familiarize them with the concepts they will be testing. Hands-on materials are left with the classroom teachers so students will be really ready for their visit. Classroom teachers are part of the instructional team, too. In cooperation with Lakeland Community College, the Center staff designed workshops to help teachers gain confidence and incorporate the experiments into their class's regular curriculum. These workshops, held on after-school time, preceded each

new topic and provided teachers with additional ideas and materials for their classrooms. They went home with a bag of tricks.

Results of the program are being evaluated by an independent consultant—actually a series, a group of consultants with business, public school, and university backgrounds. This program works because of these features, and it works because every school board has passed a resolution making it a required part of the district's educational experience for each student. We're talking now about 16 different school districts working together, all different kinds. It works because every student has six high quality, exciting science experiences each year. Their teachers get three in-service programs and lots of stuff to use in their classrooms. We are convinced that this level of support is what's required to make systemic change happen in elementary science education.

My third point: Businesses, industry, parents, colleges, government and schools have collaborated in the program's design and operation. You cannot buy a Center for Science and Math. Not yet. To make this program a reality for Lake and Geauga County children, a large number of dedicated people committed their talents, energies, and resources. The governing board of the Center includes all the school superintendents and the presidents of the colleges in the County. The board of directors, whose members are teachers, business executives, scientists, school administrators, industry, private, foundation, and government agency representatives, is responsible for organizing the instructional program and providing advice and support from business and industry. Specialized equipment is designed and built when we can't purchase it. You have in the written testimony lists of these people. So we won't go into that in great detail.

The directors developed the Center's mission statement, which is also in the written testimony. Let me just quote the first three lines.

"The mission of the Lakeland Area Center for Science and Mathematics is to make working with science and mathematics exciting and interesting for all young people so that they will develop a lifelong curiosity about the world around them."

It goes on with some specifics and their specific program goals, but with these clear targets and the full cooperation of everyone, it's no wonder our first year of operation was one of unqualified success. 20,000 plus student contacts, all third graders, six times, and nine in-service sessions attended by third grade teachers—and I might add on their own time—resulted in strong positive evidence of the beginnings of exciting systemic change in elementary science education across both counties. In 1992-'93, the coming year, we're going to double this by bringing these third graders back again as fourth graders, and hopefully we intend to add fifth.

You can see how this fits with Project Discovery because sitting right on top of that here in northeastern Ohio is this exciting new Project Discovery, which will take off and lead on into the middle school.

Finally, the Lakeland Area Center for Science and Mathematics, in our opinion, is a high-potential model for systemic change in elementary science education because—we've listed about 19 points on this written testimony. Let me highlight three or four: The schools

have made the Center program—I think this is critical—the schools have made the Center program a required part of their science education on a regular schedule. You'll see in the written testimony a sample of the daily schedule. This thing runs every day, all the time. Buses going in and out, all sorts of things happening. That's the first point. Also, it's a required part of the program.

Number two, and really critical, all children participate. Every one. We've had not only all children in regular classes, but we've served SBH classes, LD classes, different kinds of classes where children have disabilities, with an amazing amount of success, as a matter of fact. We're really delighted with that.

Third of these 14 points that I want to highlight, teachers are provided high quality, regular in-service. High quality, regular in-service. They get a lot of stuff to take back with them.

Addressing one of your points that you asked us about, the Center staff has both females and males on the staff giving all students good role models, stressing that science vocations are for everyone.

And the last one that I want to point out to you is—I think they're all important, but time doesn't permit—the inertia of "We always do it that way" has been overcome. We have enthusiastic participation by teachers in our classrooms and at in-service programs. Some of them are here, as a matter of fact. We have fought successfully through the problem of moving from theory to practice in lesson design. And believe me, that was quite a problem.

Twenty-five years ago, we determined that vocational education was critical to our nation's future. We built a network of vocational technical schools in Ohio and provided programs to all of our students here. Today, we face serious challenges in preparing our students in the areas of math and science. This science center, located at the Auburn Career Center Vocational School—you saw a bit of a clip of it there—takes advantage of excellent existing facilities, vocational and technical student assistance—the big kids help the little kids—and already established school district cooperation to bring high quality, inquiry-based science experiences to all students.

Requiring only a modest investment in personnel and equipment, a statewide or even national system of science centers such as this one could be set up quickly and have immediate impact on science and mathematics education.

Now, the year 2000 approaches quickly. Lake and Geauga County third graders in the Center program this year will enter the 12th grade—by coincidence, I guess, not by design—in the year 2000. So these kids, these very kids, are the ones we're talking about. That's why school districts, business, industry, and governmental leaders have made the Lakeland Area Center for Science and Mathematics a reality today. That's why we urge you to consider it as a model that can be duplicated for all children. With me today in the audience are Science Center staff, in-service staff, classroom teachers, parents, and some of our actual third grade scientists. I'd be most willing, if time permits to respond to any questions. And I have a feeling that the students are prepared to give you a brief demonstration of their activities as scientists if time permits that.

Chairman GLENN. Good. I think we'll be able to arrange that. But let's go ahead with the others.

Dr. Salkind, if you'd like to make your comments?

TESTIMONY OF MICHAEL SALKIND,[1] PRESIDENT, OHIO AEROSPACE INSTITUTE; ACCOMPANIED BY RENEE KENT, GRADUATE STUDENT, UNIVERSITY OF DAYTON, AND SUE ZEPP, TEACHER, WOODRIDGE ELEMENTARY SCHOOL, CUYAHOGA FALLS

Dr. SALKIND. Thank you, Chairman. I'm President of the Ohio Aerospace Institute, which is a private nonprofit consortium of nine universities, two Federal laboratories, and several dozen companies. Our mission is to facilitate collaboration among these three sectors in graduate and continuing education, research and technology transfer. The word "collaboration" is something we've heard quite a bit this morning. This institute, if you will, is a sociological experiment to teach collaboration in our society. I think that's very important in terms of the next century.

Although the mission of the Institute focuses primarily on graduate engineering education and research, through the Ohio Space Grant Consortium, we also have a major effort in encouraging more Americans, from kindergartners through college students, to pursue science and math education, with special emphasis on encouraging more women and minorities. In this, we support the President's America 2000 education strategy.

The collaborative efforts are built around two outstanding Federal Aerospace Laboratories in Ohio, NASA Lewis Research Center in Cleveland and Wright Patterson Air Force Base in Dayton. Both facilities act as magnets to attract visiting faculty, students, and industry collaborators to work with each other, have access to the world class experimental and computational activities, and work on cutting edge, real world programs. In this way, graduate students experience an enriched education by being exposed to industry and government perspectives.

Collaborative activities within OAI are conducted by focus groups. These are networks of colleagues from the three sectors who develop common strategies in both research and education. They conduct research, develop courses, conduct conferences, seminars, and workshops to advance the state of knowledge in their areas of expertise. There are 13 such focus groups in diverse technologies such as advanced materials, propulsion, power, computer simulation, dynamic systems and control, visualization, and aircraft icing—something very much in the press recently.

Through direct industry participation, these focus groups bring a market perspective to the research agenda and the educational agenda. In this way, technology can more expeditiously be used to impact economic development.

To encourage more Americans to pursue degrees in engineering science, the Ohio Space Grant Consortium, managed by OAI, has awarded more than $1.8 million in the past three years to 52 graduate and 78 undergraduate students to help support their education. The funding has been provided by the NASA Space Grant Col-

[1] The prepared statement of Dr. Salkind appears on page 151.

lege and Fellowship Program and NASA Lewis Research Center with matching funds from the State of Ohio and industry.

The Director of the Ohio Space Grant Consortium is Dr. Paul Claspy, who's here today. He's also the Director of Education at the Ohio Aerospace Institute.

With me today is Renee Kent, who is a recipient of a NASA Space Grant/OAI Fellowship. She is a doctoral student in the Materials Engineering Department at the University of Dayton, one of the OAI member universities. She expects to receive her Ph.D in August 1992 and has been a resident at OAI for the past two years. She has been conducting her thesis research in the Structure Division of the NASA Lewis Research Center. The focus of that research has been the development and implementation of new methods for determining mechanical properties of new fibers. These new high-strength materials are being developed for high temperature structural applications, such as the National AeroSpace Plane and future high performance jet engines. Her experience here has also brought her in contact with industry collaborators and considerably broadened her educational experience. Renee came to observe that her educational experience was characterized by many teachers and mentors who found great excitement in their own scientific endeavors as well as the development of young people. She felt that when learning and discovery were introduced in exciting ways, she and her fellow students learned successfully.

If we are to attract more young Americans such as Renee Kent to pursue technical careers in graduate education, we must insure that more young people are motivated to study math and science in the primary and secondary grades. To this end, we established the Ohio Space Grant Consortium Education Pipeline Committee, which includes members from primary and secondary education, from universities, from Federal laboratories, and from industry. They conduct programs for teachers and students in kindergarten through graduate school with special emphasis on female and minority students. Attached to the written testimony is a summary of some of these programs, but I want to talk about a few today.

Because OAI is a network of engineering and science practitioners, it serves as a reservoir of volunteers to work with teachers and students. The Ohio Space Grant Consortium is planning to develop this network of volunteers and link them with local school systems.

One of these activities has been a series of workshops for elementary school teachers to introduce the World In Motion program developed by the Society of Automotive Engineers. This program, developed by a national team of educators and practicing engineers uses mobility technology, such as small cars and boats, for learning basic principles of physical science and math. In addition to the teacher workshops, practicing engineers and engineering students are made available to assist teachers in and out of the classroom.

With me today is Sue Zepp, a third grade teacher in the Woodridge Elementary School in Cuyahoga Falls. Mrs. Zepp has used the World In Motion program in her class with exciting results. She used it in a reading module, rather than a math or science module, and found it could fit into anything. By the way, that's the curriculum crunch issue that Dr. Parrish talked about earlier. Mrs. Zepp couldn't find any space in the math and science modules.

Mrs. Zepp felt that this program was the kind of hands-on, cross-disciplinary, cooperative education experience that is being encouraged by education experts and emphasized in the American Association for the Advancement of Science Project 2061.

I want to just stop and talk about 2061 for a moment for those of you not familiar with it. The year 2061 is when Halley's comet will return to the U.S. And Project 2061 is clearly a long-term effort to strengthen our science and math education. And it again reinforces what we've said before, that this is not something that will have a quick fix. We need to make a long-term commitment here. Project 2061 brought together experts in education and math and science for a study by the American Association of the Advancement of Science. The results were published in a book called *Science And Math For All Americans.* It really is a blueprint for science and math and education reform and contains many of the elements we talked about earlier: hands-on, exciting activity, deemphasis on content and more on the context, which deals with the curriculum crunch issue.

Mrs. Zepp's experience with the World in Motion program was very positive. She was very excited by the experience with this activity because while traditional abstract math modules have little meaning for students, they learned advanced math skills and used their calculators in order to determine averages and trends in their World In Motion experiments. In letters from this year's third graders to next year's third graders, her students mentioned the World In Motion experience with great enthusiasm.

Another program we've conducted involved bringing 150 Girl Scouts to the Cleveland Children's Museum on three successive weekends for programs using the museum's hands-on water, bridges, and time exhibits. The program was conducted in conjunction with the Society for Women Engineers, and adult women practicing engineers served as role models for the six- to ten-year old girls who participated. We need more such programs to counter the social stereotypes that discourage women and minorities from pursuing math and science.

From our experience, I'd recommend that the Federal Government consider the following in order to improve the education of American students in math and science:

We have a cadre of practicing scientists and engineers in industry, universities, and Federal laboratories who are competent and comfortable in math and science. If we can harness that talent pool to assist teachers and students in our primary and secondary schools, we can make significant improvements. American professional technical societies, through programs such as the World In Motion and Math Counts, are helping bring this army of volunteers to focus on our schools, but they need help. They need funding to provide the staff efforts to support such programs and the data base management to couple a dispersed army of volunteers with local schools. Such services must be organized on a local or regional basis because our school systems are local. We need to help stimulate the creation of such a local or regional infrastructure. The National Science Foundation Statewide Systemic Initiative, Project Discovery, which we heard about from the first panel, has the potential to help create such an infrastructure.

We need to build new regional resource centers such as the one we heard about from Dr. Porter. And we must find ways of integrating the many existing support programs into these regional resource centers so that our schools can connect to those resources more readily.

There are currently many diverse programs for coupling volunteers with local schools. NASA Lewis Research Center in Cleveland has a wonderful educational resource center for teachers. They also have many employees participating in volunteer programs with local schools, such as the program with East Technical High School and the local physics alliance. Wright Patterson Air Force Base in Dayton has similar programs to couple employees with local schools.

Our universities and our private companies also are engaged in programs such as this. We certainly heard about the university activities earlier today. Private companies participate in a broad range of efforts including adopt-a-school programs. Several years ago, a local agency catalogued such programs in northeast Ohio. The result was a rather thick book. Both the schools and would-be volunteers are overwhelmed by the number of such efforts, which makes it more difficult to channel specific capabilities to specific needs. We need well-staffed regional resource centers to maintain current data bases of such capabilities and expeditiously bring capabilities together with needs. This is no small challenge. Current programs are not adequate to address those needs.

The Federal Government can also help by supporting consortia to help bring together resources for collaboration. We need to promote collaboration both in education and research. The NASA Space Grant College and Fellowship Program, with consortia in all 50 states, the District of Columbia, and Puerto Rico, is a major national program with specific mission responsibility for kindergarten through graduate school in engineering, math, and science. It is an excellent vehicle for effecting change.

I would recommend that the Federal Government investment could be most effective if focused as matching funds for consortia demonstrating the ability to attract private sector as well as state and municipal funding. I would also strongly recommend tax incentives for industry investment in education and research, and especially for collaborative activities through consortia. These programs could be especially effective if they provide incentives for coupling private sector efforts with Federal laboratories.

In summary, I would recommend that we:

(1) Strengthen the coupling of Federal laboratory and university engineers and scientists to our educational enterprise through targeted programs, consortia, and tax incentives;

(2) Support the innovative educational programs such as the Society for Automotive Engineers' World In Motion program that provide exciting, engaging, hands-on modules to school teachers and volunteers to help those teachers implement them;

(3) Develop regional resource centers, such as are being developed through Project Discovery, to maintain innovative math and science programs and to maintain the staff to help schools select and implement such programs.

Thank you.

Chairman GLENN. Thank you very much. Let me ask a couple questions of Ms. Kent and Mrs. Zepp before we get back to Dr. Porter.

Renee, are you going to be going out in the engineering work force, looking for a job in engineering?

Ms. KENT. I am looking for a job presently.

Chairman GLENN. Because of the cutback in military, of course, we have a lot of engineers and even scientists who are having some problems getting jobs. What's been your experience in this job search problem?

Ms. KENT. I'm one of those people having problems getting a job. I'm graduating in August, and I'm a person who is graduating with a 3.9 something cum. I've gotten awards for my Master's research, awards for my Ph.D research, and I'm still having a very difficult time getting a job. And what I am finding is that most people, including NASA, are telling me "We would really like to hire you, but we just aren't hiring anyone right now." So it's very discouraging and it's very frustrating. I think it makes sort of a sad commentary for the future.

Chairman GLENN. Well, I personally hope that some of this is temporary, as you do, too, of course. I hope it's temporary. And we do have a lot of people right now, because of the cutback in aerospace and military contracting, particularly out on the West Coast, who are really in a bad situation. We have some of that here in Ohio, also, but long term I think there isn't any doubt about what we need for the long haul. I hope we get situated as soon as we possibly can.

Sue, speaking of the hands-on approach used in the World In Motion—I was wondering, when Dr. Salkind was speaking just a moment ago, do you find an equally increased interest in math as well as just in scientific concepts? There's a difference with people coming in and having hands-on and having all the A works, B works, C, type thing. That's interesting and everybody loves to do it. Is there a spill-over, then, into increased interest in math because you have to have a basis in math to really go ahead in science to any depth.

Mrs. ZEPP. My whole classroom is kind of all hands-on. I once described my classroom as organized chaos. So I have a lot of manipulative——

Chairman GLENN. Sounds like my kind of classroom.

Mrs. ZEPP. We have fun. I think learning should be fun. And so there's really spill-over. I don't know exactly how to put it. The math and science in this program work is so close together that there wasn't any separation.

Chairman GLENN. Dr. Porter, do you want to have your junior scientists here?

Dr. PORTER. Thank you, Senator. You understand that this is not a play or a production. This is a bit of a science experiment as you might see these youngsters working with. We have four junior scientists this morning. Maybe they will come up here along with the director of the center. Joe Nalon, Jason McGinness, Sally Roth, and Kay Kablowski. I think I have one additional scientist who is Mike Mitchell. Good. And I didn't have him X'd out. But these youngsters are third graders in Lake and Geauga County Schools.

They have been involved with the Lakeland Area Center this year. And Claire Zurbeck, the Director of the Center, is there. Looks like we have one more as well. So Mike Mitchell must be here also; is that right, Mike? And Brad Uhall. We got all these names out.

Ms. ZURBECK. Normally when they come in they're in a team situation.

Chairman GLENN. Just pick up that mike.

Ms. ZURBECK. Normally, the class is about 24 students. We divide it up into teams of essentially about four. So we usually have six teams coming in on a team concept. You'll notice that each one has essentially four different colored aprons. It designates the position they have, the job, such as the experiment director, recorders. All of them do the experiment, though. They're all getting the hands-on experience.

And we have an example of one of them. This was the last one we did. We have three different visits each class made. The last one was on electricity and magnetism, which is back there. This is actually the second visit on light and sound. And we see we have some fairly sophisticated equipment such as the oscilloscope. The oscilloscope, if it operates properly, they'd like to do an example of what it's like when they come in and perform the experiment. So I think Joe is the reader. So if you want to read——

(Demonstration had.)

Dr. PORTER. Senator, what you have to remember is that every third grader in both counties has had this experience. Every third grader. That's almost 3,000 or more of them, along with some others. So it's a saturation program.

Chairman GLENN. Have you been at this long enough yet to follow up and see how many of the students had an increased interest in going into the physical sciences?

Dr. PORTER. This is the first year of operation in the Center. We do have a research piece that's designed to get at that, and it's currently being worked on right now. It's rather massive. But we do have outside consultants involved in this, and we hope to have some hard data, as hard as educational research can be. You have to understand there's a lot of things going on there.

Chairman GLENN. Thank you very much. I really appreciate your being here this morning.

Thank you all. Kids, thank you very much for being here this morning and participating. That's great. We really appreciate that. Thank you all very, very much.

Our next panel, our last panel that has been patiently waiting—or not so patiently waiting, as the case may be, but we appreciate your staying with us this morning—is a panel on "Selected Ohio Programs for Underrepresented Groups, Women and Minorities, in Science and Math Education."

Ms. Elizabeth Obara is the Camp Director for the Buckeye Women in Science, Engineering and Research Summer Camp, which acronyms downs to B-WISER, of the Ohio Academy of Sciences. It's a summer science camp for seventh grade girls to stimulate girls' interest in science.

Ms. Gardenia Butler is the Executive Director of the Minorities in Mathematics, Science and Engineering program in Cincinnati, a model program to improve and retain minorities in science.

Accompanying her is Mr. Erik Thomas, an eighth-grade student at Mount Healthy South Middle School in Cincinnati participating in Ms. Butler's program.

And Dr. Prem Batra is a Professor of Chemistry at Wright State. He's the principal investigator of a model program designed specifically for inner city minority use, accompanied by Ms. Latrice Turpin, recent high school graduate from Meadowdale High School in Dayton. Ms. Turpin benefited from Dr. Batra's program, and she will major in science at Ohio State this fall.

Ms. Drucilla Veasley is a biology teacher at Dunbar High School. Ms. Veasley was retrained at Dr. Batra's program, and she has diffused her new knowledge to her high school classroom. We welcome you here this morning and appreciate that very much.

Ms. Obara, if you want to lead off with your comments?

TESTIMONY OF ELIZABETH OBARA,[1] CAMP DIRECTOR, BUCKEYE WOMEN IN SCIENCE, ENGINEERING AND RESEARCH INSTITUTE, OHIO ACADEMY OF SCIENCES

Ms. OBARA. Mr. Chairman, Members of the Committee, Friends and Colleagues, my name is Elizabeth Obara. Since 1987, I have been a science teacher at Dublin High School, Dublin, Ohio. Prior to that, I taught 22 years in Indiana, Germany, and Ohio. As a classroom teacher on the front line of education, I am particularly pleased to accept your invitation to appear before you today to discuss the B-WISER Institute, a summer camp and follow-up program which empowers young women to achieve in science.

The mission of the Ohio Academy of Science, a nonprofit organization of those interested in science and technology, is to empower curiosity, discovery, and innovation by stimulating interest in the sciences and technology, promoting and supporting research, improving science education, disseminating scientific knowledge, and recognizing and publicizing high achievement in attaining these objectives. Through its Junior Academy, Senior Academy and Central Office, the Ohio Academy of Science provides support activities, runs annual meetings and science fairs, and publishes a journal and newsletter that reports developments in science, engineering, technology, and education.

In a special report entitled "Minorities in Science" in the April 15, 1990 issue of "Chemical & Engineering News," John Danek of the National Science Foundation wrote, "We have created artificial situations in which there are no alternative pathways to successful careers except for children to do well in a very short window that begins at the seventh grade. To keep up, science will have to attract more minorities and female students."

The B-WISER Institute is a creative and effective response to these issues. What is B-WISER Institute? The Buckeye Women in Science, Engineering and Research Institute. The B-WISER Institute is an educational partnership of the Ohio Academy of Science, WISEMCO—the Women in Science, Engineering and Mathematics Consortium of Ohio—and the College of Wooster. This yearlong program consists of the B-WISER summer science camp at the Col-

[1] The prepared statement of Ms. Obara appears on page 163.

lege of Wooster where seventh grade female students and a follow-on research internship for students under the supervision of professional women in science in colleges and universities, government, and industry. The program is supported in part by a grant to the College of Wooster from the Ohio Board of Regents for funds available under the Eisenhower Science and Mathematics Education Act.

The purpose of the B–WISER Institute is to enhance the interest of 100 seventh grade girls in physics, chemistry, biology, geological science, computer science, and math. The Institute consists of three activities: a summer B–WISER camp at the College of Wooster; a yearlong internship for each of the 100 research interns with the exemplars, who are the women in science identified by the Ohio Academy of Science; and a career workshop for the 100 research interns, their parents, and their supervising exemplars.

The program builds on efforts of an existing partnership between the College of Wooster and the Ohio Academy of Science for the B–WISER, the Buckeye Women in Science, Engineering and Research Camp, held on June 9th through the 14th, 1991. The camp is a team taught, hands-on, residential experience using well equipped classrooms and facilities at the College of Wooster. Most of the 18 faculty members at the Camp are pre-college teachers, well known in Ohio for their ability to affect student attitudes in learning in science and mathematics. Moreover, the B–WISER Institute taps the talents of nearly 100 of over 250 exemplars who are volunteer women in science, engineering, and mathematics for the Ohio Academy of Science.

The research interns, young women entering the eighth grade in the fall of 1992, seventh graders during the school year 1991-'92, will be approximately 21, 22 years old and ready to enter the work force or graduate school by the year 2000. Therefore, it is very important that we begin training these young women now to the full participation in mathematics and science to avert the predicted future shortage of talent.

The goals of the B–WISER Institute are: To develop student content knowledge in specific sciences and math; to develop students skills in the process of scientific investigation and research methods, including selecting a research topic, developing testable hypotheses, devising tests, and collecting data and drawing conclusions; to enhance student awareness of career possibilities and requisite qualifications for careers in scientific disciplines; to generate enthusiasm for science and a sense of participation in scientific discovery; to facilitate student assessment of potential skills and abilities for scientific careers; to place 100 young women research interns with professional women exemplars so that the research intern may work on science project with a role model, mentor throughout the 1992-'93 school year; to enable the research intern to present her project for judging at a local, district, and state science day at the end of a yearlong scientific experience with the exemplars; to hold a one-day career conference in the fall of 1992 with research interns, counselors, financial aid experts, and college admission officers from the Ohio colleges and universities; to prepare three Early Alert Tip Sheets to Careers in Science, Engineering and Mathematics, on the topic of admissions testing, scholar-

ships available, and youth science opportunities such as the American Junior Academy of Science, the Westinghouse Science Talent Search, and the International Science and Engineering Fair.

As a result of participating in this year-long Buckeye Women in Science, Engineering and Research Institute, the research interns will do the following: It will include additional science and mathematics in their choices for high school classes. They will continue to do scientific research during high school, either with the exemplar role model or with another scientist. She will prepare her science project for judging at local, district, and state science days. Will be able to know where to apply for research funds and then receive them. They will be more knowledgeable about science careers and the ways in which to assess them. They will be very aware of many opportunities in the Ohio Junior Academy of Science, the Junior Science and Humanities Symposium, the Ohio Academy of Science Annual Meeting, and the International Science and Engineering Fair. They will be able to plan for a career in science, engineering, or mathematics when she enters college.

The B-WISER Institute will build on an existing partnership and extend the camping experience into a year-long research internship through the engagement of exemplars of the Ohio Academy of Science. The 250 currently active exemplars represent more than 140 cooperating employers, including such well known companies as Adria Laboratories, American Electric Power Service Corporation, Ashland Chemical, B.F. Goodrich Company, Battelle Memorial Institute, BP America, Chemical Abstracts Service, Columbia Gas of Ohio, Dow Chemical USA, DuBois Chemicals, Dupont Corporation, Ferro Corporation, NASA Lewis Research Center, Ohio Power Company, Procter & Gamble, Ross Laboratories, Scott Fetzer Company, SofTech, Incorporated, the General Electric Company, the Kroger Company, Timken Company, the Toledo Edison, United Telephone Company of Ohio, Westinghouse Materials Company, and Whirlpool Corporation.

At the 1992 B-WISER Camp at the College of Wooster, there were 100 students from more than 72 schools in 36 of Ohio's 88 counties. Urban, rural, public and non-public schools were well represented as shown on the attached list of participants.

The staff for the B-WISER Institute consisted of Dr. Ted Williams, Project Director for the College of Wooster; Mr. Lynn Elfner, Assistant Project Director for Ohio Academy of Science; Elizabeth Obara, B-WISER Camp Director; Dr. Lois A. Cook, Assistant Director; and Dr. Nadine Hinton, Evaluation Consultant.

Mr. Chairman, although my remarks today have focused specifically on the B-WISER Institute, I respectfully request on behalf of the Ohio Academy of Science that you leave the record of this hearing open until July 10th, 1992, to enable the Academy to submit additional written testimony relative to the question concerning systemic change in education.

Although more detail will be submitted in additional written testimony, I do want to point out now a specific change in Federal law which could facilitate the creation of many more programs like the B-WISER Institute. One of the problems with the legislation which authorizes the Eisenhower program is the bias against not-for-profit organizations like the science academies, science centers, and

museums and other community-based organizations. At this time, the Academy cannot receive funds directly from the Ohio program. We are forced to use academic institutions as fronts for proposals. This is a disincentive to creativity and innovation in program design and administration. It impedes the proposal development process, puts up barriers to inter-institutional cooperation, and imposes additional administrative costs on already overburdened system. The Academy feels that the competition for Federal grants should be wide open. The best ideas and programs should be funded without a built-in administrative filter.

In conclusion, the Academy feels that the B-WISER Institute empowers young women to achieve in science. In his book entitled The Best Of Success, Wayne Davis writes, "Power comes from knowing how to do something. People with power are people who know how to get things done. And sometimes knowing how to do something is virtually the same thing as having done it. So when we educate ourselves, we build power to accomplish our goals."

The B-WISER Institute will help young women achieve their goals in life. The B-WISER Institute is an empowering experience. Thank you for the opportunity to testify today before your committee. I will be pleased to respond to any of your questions concerning the B-WISER Institute.

Chairman GLENN. Thank you very much. And we will keep the record open, as you requested, until the 10th or a couple days beyond that.

Ms. OBARA. Thank you.

Chairman GLENN. That will be fine.

Ms. Gardenia Butler?

TESTIMONY OF GARDENIA BUTLER,[1] EXECUTIVE DIRECTOR, MINORITIES IN MATHEMATICS, SCIENCE AND ENGINEERING; ACCOMPANIED BY ERIK THOMAS, MOUNT HEALTHY SOUTH MIDDLE SCHOOL, CINCINNATI

Ms. BUTLER. Good afternoon, Senator Glenn. We bring you greetings from Cincinnati, Ohio, and we're very happy to be able to testify today.

M²SE is the acronym for the Minorities in Mathematics, Science and Engineering. The M²SE Center is dedicated to significantly increasing the number of students of color who are motivated and prepared for math, sceince, and engineering careers. We were founded in 1989 as a nonprofit organization. The M²SE Center is a Cincinnati-based, expanding consortium of business and industry, colleges and universities and public school systems. Some charter members are: Procter & Gamble, Cincinnati Gas & Electric Company, General Electric, Cincinnati Bell, University of Cincinnati, the Cincinnati Technical College, as well as the Cincinnati Public School District. In less than four years, in addition to the list I just articulated, we have also added Eastman Kodak, Xavier University, Center College. We have budding partnerships with Miami University, and the National Action Council for Minorities in Engineering.

[1] The prepared statement of Ms. Butler appears on page 175.

We started our program in 1989 in two pilot middle schools, and we have grown from those two schools with 60 students to now an enrollment in 18 schools of 700 students. We were recently awarded an NSF grant proposal for five years of funding. That award established us not only as a Cincinnati-based Regional Center for Developing Minorities, but it also gave us enough funding to begin to extend into the nine states within the Midwest.

Who is our customer? Our primary customer is students of color, and we are focusing on C average and above students. There are a lot of very good programs that focus on gifted and talented or socially disadvantaged students. We're going to do our part in the Midwest to really increase this minority pipeline and prepare the future work force. We feel our biggest challenge is to attract and retain those students interested in math and science in the C average grade level. Those students must also have good attendance and good behavior and strong parental involvement.

Now, although the students are our primary focus, we know that for us to be successful, we must pay attention to the teachers. We are about not only reform to curriculum, but we're increasing awareness and appreciation for the fact that the students that the teachers serve, because the future work force, will be more minorities in coming years. So we're focusing on an appreciation and awareness of their culture, the students that they serve. We're looking at innovative strategies for delivering the curriculum different than has been done before. And to that end, we have an annual Summer Teacher Institute that is hosted by our consortium and member universities that provide seven days of training and three hours graduate credit for those teachers. In addition to teachers and students, we're focusing on parental involvement through the formation of Say Yes to Family Math, teacher-parent and student groups, using that concept which was developed by the National Urban Coalition, which is done in several large community-based organizations across the Nation.

In addition to focusing on the teachers, what we're doing is we're trying expose students to African Americans and Hispanics and Native Americans who are professionals who are in math, science, and engineering careers; we're providing hands-on experiments and making fun those math and sign experiments that those students are participating in. The students are starting in grades 4 and go through grade 12 and have all kinds of concentrated academic in-class and after-school class experiments that they are involved in. They participate in additional competitions in math and science both city and state and national. Also, the parent component, the parents and the students participate in a math and science enrichment program. Those are just some of the highlights the students have participated in.

I also want to share with you that being a new program, we know that it's important that we begin to track those students and how well they are doing. And we are happy to share with you today, after three years, we've been able to retain with this type of a program at least 70 percent of the students who have started with us. We feel like in Cincinnati, with the regional status and also the National Science Foundation, the dedication and energy and willingness of the industries that are involved, the parents and

community organizations, that we are poised and ready to do our part in the Midwest to continue to develop students of color.

The other thing that I would like to also emphasize is that we know that this problem is a very, very complex one, and we know that we can't do it alone. So we are establishing strong collaborative partnerships with entities such as the Ohio Math and Science Discovery Project. We're also reaching out to student organizations such as the National Technical Association, the National Society of Black Engineers, and also the American Chemical Society. And through these collaborations, we feel like there are other existing programs that do some aspects of what we want to offer to our students, and we will join hands with them such that our dollars will stretch farther. And we will be able to insure that by the year 2000, we will graduate many, many more students of color in the Midwest.

Thank you.

Chairman GLENN. Thank you.

Dr. Batra?

TESTIMONY OF PREM BATRA,[1] PROFESSOR, DEPARTMENT OF BIOCHEMISTRY, WRIGHT STATE UNIVERSITY; ACCOMPANIED BY LATRICE TURPIN, RECENT HIGH SCHOOL GRADUATE, MEADOWDALE HIGH SCHOOL, DAYTON, AND DRUCILLA VEASLEY, BIOLOGY TEACHER, DUNBAR HIGH SCHOOL, DAYTON

Dr. BATRA. I am Prem Batra, Professor of Biochemistry at Wright State Universtiy.

It is no secret that minorities and women are underrepresented in the sciences. One reason why the minorities are underrepresented is that many minority high school students are not academically prepared for college science studies. This brings me to our model project that is based at Dunbar High School, an inner city Dayton public school with a student body that is almost 80 percent African American. The underlying objective of the project is to improve the academic performance of the inner city high school students through a variety of intervention programs designed to motivate them and encourage their entry into the science profession.

The project involves a partnership between Wright State University, Dunbar High School, and the private sector organizations, including Mead Corporation, Lifescan, Incorporated, Milton Roy Company, Procter & Gamble, Kettering Medical Center, and Marion Merrell Dow.

I appear before you to describe our project. Four high school students and one science teacher who have participated in our program have accompanied me to these hearings. I want to share with you what they have to say about their participation in the program.

Latrice Turpin, sitting on my right, a recent graduate of Meadowdale High School, has this to say: "I knew I wanted to go to college, but I did not know what to major in. It is only after participation in the Summer Research Program that I decided to major in pharmaceutical science at Ohio State this fall."

[1] The prepared statement of Dr. Batra appears on page 189.

Rashida Seldon is a senior at Dayton Christian High School and says, "The program greatly increased my interest in science, and I now have a yearning for the medical field."

Elgin Kight is a senior at Dunbar High School, and he indicates, "I never thought about doing research, but after completing this program, I found biomedical research more exciting than accounting. After high school, I now plan to major in biology and do research in genetic engineering."

Justina Brown, a senior at Northmont High School, says, "The Summer Research Program gave me more initiative to do my best in math and science courses. It is because of my participation in this program that I decided to pursue a career in the health sciences."

Drucilla Veasley, sitting on my extreme left, is a teacher and teaches biology at Dunbar High School. About her participation, Ms. Veasley has this to say: "This past school year was very successful for me, and I attribute that to my participation in the Summer Research Program last year. Not only did I develop long-term professional relationships with Wright State faculty, my summer experience also enabled me to do some of the hands-on experiments with my students in the classroom." All of us are very proud of these individuals.

Our project has two components: an academic year component and a summer component. I'll briefly outline the activities in both these components.

The academic year component is based almost entirely at Dunbar High School and involves several objectives, strategies, and activities. These are:

One, updating and enhancing science courses to insure the accuracy of science content in high school classes, particularly in the area of molecular biology and biotechnology.

Two, performing hands-on, modern laboratory experiments. The idea here is to make the students feel that science is fun and non-threatening so that science courses become exciting opportunities to learn.

Three, informing students about opportunities in the sciences. This involves taking students on field trips to university and private sector laboratories so that they can interact with minority and women scientists as well as bringing minority and women scientists into the classroom.

Four, improving the professional status of science teachers and minimizing their sense of professional isolation. This has been done by developing collaborative activities between Wright State faculty and the science teachers such as writing joint grant applications, presenting papers at scientific meeting, writing a joint paper for publication and developing new science courses.

Five, preparing and facilitating the transition of high school students for college science studies. To facilitate the transition of minority and women students from high school into college, we plan to offer this fall a modern introductory biology course for advanced and gifted students at Dunbar High School. Students who successfully complete the course will qualify to receive college credit. Emphasis on the course will be on hands-on laboratory experiments

dealing with the cutting edge, modern molecular biology and biotechnology areas including gene cloning.

Up to this point, I've outlined the academic year activities. I now turn to the extremely important summer component of enhancing science education of both minority and women high school students and motivating them to pursue science careers. The Summer Research Program is of seven weeks duration and has major two objectives: (1), mentoring by professors while giving minority and women students a meaningful hands-on experience in scientific research. And (2), updating the scientific skills of the pre-college science teachers who teach minority and women students. Each student is assigned to a faculty member and the students work as research apprentices for a period of seven weeks. The teachers are also assigned to research faculty, and they work relatively independently in ongoing research projects. The idea is that the teachers will become familiar with modern research tools and techniques so that they will, in turn, bring a sense of excitement to the classroom and stimulate their students to pursue science careers. The student apprentices and science teachers work eight hours a day for a 40-hour week for the seven weeks. Each student is paid $1,000, and each teacher $2,000 for the seven-week program.

We began our Summer Research Program quite modestly in 1991 with seven African American students and one science teacher. The 1991 summer program was so successful that 104 students and 17 science teachers applied to participate in the 1992 summer program. However, we only had the resources to accommodate 17 students and 6 teachers. These individuals are presently working in faculty laboratories. Four of those students, Latrice Turpin, Justina Brown, Rashida Seldon, and Elgin Kight, who are participating for the second year, are here with me. And the science teacher, Ms. Drucilla Veasley, is also here for these hearings.

Let me now outline what more needs to be done. One, the summer research program by itself is not enough. We need to implement year-round science enrichment programs for minority and women high school students so that they can work as research apprentices throughout the year. Yes, Senator, there need to be more school days per year and longer school days.

Two, at the Federal level, each major granting agency, such as NSF and NIH, should establish a separate pre-college science enhancement division. Through its funding mechanisms, the Federal Government can do much to encourage and support the development of human resources for science and engineering.

Three, a stable multi-year funding base is critical if pre-college science enrichment and intervention programs are to succeed. A multi-year grant award would not only give us time to plan ahead, it would also provides us the opportunity to track the students with respect to their academic success in college and career selection and retention.

Four, there is a need to institute tutorial programs for students during and after school hours. Such programs should be staffed by academically strong undergraduate and graduate students who would act as teaching assistants and role models.

Fifth, to further increase the pool size and quality of minority and women students for college science studies, we need to bring

the science enhancement programs into the pre-secondary grades. And we need to insure that the teachers teaching at these levels have the proper scientific background and resources to do the job effectively.

Six, the inner city public schools lack the resources to make the drastic changes needed to improve science education, including the need to revise and organize science courses. The schools get can only do this cooperatively with help from the universities. And the university scientists must play a key role in this effort. Thus, steps should be taken at the state level to promote linkages and partnerships between public universities and public schools. The ongoing partnership between Wright State and Dunbar School can serve as a model. The Board of Regents and the State Board of Education working together can make this a reality.

Seventh, finally, I would urge the Federal Government and the private sector to make efforts to expand the job market for scientists in general and for minority and women scientists in particular. Senator, I think you alluded to this earlier. This in itself would be a great incentive for minority and women students and entice them to pursue careers in science.

Senator on behalf of all of us involved in this exciting endeavor, I thank you for providing us with this opportunity to describe our program and for your interest in and concern about enhancing precollege science education in general and for minorities and women in particular.

Thank you.

Chairman GLENN. Thank you very much, Dr. Batra.

Latrice, what encouraged you to go into science? Was it mainly a personal interest that Dr. Batra and his associates took in you, or is it that you suddenly found that math and science are exciting? What happened, can you tell us—all of the above, maybe?

Ms. TURPIN. It's a little bit of all the above. Ever since I was in sixth grade, I've always wanted to go into science I don't know why. I always was interested in it. But when I got to Ohio State—not Ohio State, but Wright State, I'm sorry——

Chairman GLENN. You're going to Ohio State?

Ms. TURPIN. Yes, I'm entering Ohio State.

When I got there in the program, I was more involved in the science and I've gotten more experience in the college setting. It's different from high school. And in the program, I've gotten to work with sophisticated equipment. I got to see things that I would never see in high school, such as working with live laboratory mice. And it has sparked my interest.

Chairman GLENN. What do you want to get into eventually? Do you know yet?

Ms. TURPIN. Yes, I want to go into pharmaceutical chemistry. From last year, I had worked with Dr. Ketcha in organic chemistry laboratory and what he was doing. It was his enthusiasm that got me very interested in chemistry. I've had two years of chemistry in high school, so that played a part in it. So it's just the enthusiasm he showed for his work.

Chairman GLENN. Is your math pretty good?

Ms. TURPIN. I've taken calculus, yes.

Chairman GLENN. If you are getting into advanced organic, you're getting into some pretty good math.

Erik, what turned you on to M²SE?

Mr. THOMAS. Well, I guess it was because I enjoy math a whole lot ever since I was real small. I like accounting and adding up. I've always enjoyed math. And M²SE was mainly a math program, so that interested me a whole lot.

Chairman GLENN. How long have you been in the program?

Mr. THOMAS. Well, last summer, I was in the summer program, but I wasn't actually in M²SE. So this year was my first year in M²SE.

Chairman GLENN. What do you want to do eventually? Do you know yet?

Mr. THOMAS. I want to be a computer designer.

Chairman GLENN. Computer designer? That's a fertile field these days, that's for sure. It's growing so fast you can't keep up with them.

Ms. Drucilla Veasley, you're a teacher now, right?

Ms. VEASLEY. Yes, I am.

Chairman GLENN. You heard we were discussing earlier some of the things about getting parents involved and so on. Have you had any problems with that in this area of math and science in particular, about getting the parents involved with what the kids are doing?

Ms. VEASLEY. It's interesting that you should ask me that question. I have always had an interest in trying to get the parents involved in my classroom. One of the things that I have done, I always ask my students if any of their parents are in a science area, and I ask them to come in to speak to my students. For instance, when we were doing the human body, I had a young lady, her aunt, who was her guardian, was a respiratory therapist. So she came in to share with the students about her career, her educational background, things like that.

I've also had parents come in to volunteer their time to help my students.

Chairman GLENN. Ms. Butler, how many school districts will M²SE be able to impact? What do you see as the ultimate goal?

Ms. BUTLER. We see 22 cities across the nine states, approximately five districts per those 22 cities. So about 15,000 students by the year 2000. The grant provides an opportunity to touch 51 schools in the greater Cincinnati area and northern Kentucky and about 2,800 students.

Chairman GLENN. What's the basis of your program? Is this more emphasis on this and more personal contact with the students and so on?

Ms. BUTLER. The emphasis is on providing a comprehensive approach to the academic development of the students; that is, understanding of where they came from, their heritage, also exposure to math and science, and also field trips and different kinds of things that will enable them to really make math and science relevant in their everyday lives.

We do have a component of working with the University of Cincinnati and some of our other colleges. The summer institutes are being held at those campuses. And in these hard economic times,

I'm proud to share with you, the University of Cincinnati will be offering to those students who started out as a C average student in M²SE that maintain a B average, because we believe our program gives students a jump start and it helps them to quickly become B and A average students, the University of Cincinnati will be providing to B average students through the summer institute one year of free tuition for every consecutive year that they participate in the program. And we're working very, very hard to make sure that the other universities that are involved will pick up the idea and do the same.

Our industry partners are now beginning to take a look at, can they provide meaningful summer jobs for rising seniors as opposed to heretofore most industries only want to employ students in their sophomore year in college. We found that there are some successes with students starting early and having responsible rolls in industry.

And another thing I'd like to share with you is the Engineering Design Clinic, which we think for those students who have really determined that they want to be an engineer, we have them in their junior year match and participating with an engineering professor and a team of sophomore and junior engineering students in college to solve engineering problems. And they are participating and learning in a cooperative way how to approach those kinds of things.

Chairman GLENN. Dr. Batra, I have—let me ask you, do your programs provide the students with long-term exposure to science and math? Is that part of it?

Dr. BATRA. Yes, but only at Dunbar High School. And we would like to extend our summer program to the entire year. But we do have an ongoing program with Dunbar High School where we do send out faculty to various science classes during the academic year, and they do hands-on experiments, demonstrations and workshops for teachers, and students.

Chairman GLENN. The reason I was asking that, I have a legislation that I have proposed that's in now for consideration at the committee level, Senate Bill S. 685. It would establish a summer science academy for talented but economically disadvantaged minority young people. And it calls for long-term commitment, though, in educating these young people. The program and the bill would bring selected seventh through twelfth grade students in every summer through that time period so this they could develop the self-esteem, the necessary skills for college and the work place. And that isn't true yet. We don't have it in place yet, but I proposed that, and we hope to get that through before the end of this year. It would be a longer term commitment.

Now, maybe asking for that kind of commitment out of seventh or eighth graders is a bit much, but do you think that's a feasible way to go at this?

Dr. BATRA. I think that's very feasible and I give you credit for introducing that bill. It arrived in the mail as I was leaving Dayton yesterday, so I did not get a chance to look at it in detail, but I glanced through it, and seems like an excellent idea. But I would go a step further. Give us an opportunity to expand the summer

program throughout the academic year, say on Saturdays and after school hours.

Chairman GLENN. Instead of just making it residential through the summer period, have it something that could be——

Dr. BATRA. In addition to.

Chairman GLENN [continuing]. Two Saturdays a month or something like that?

Dr. BATRA. Or even after school closes at 2:15 P.M. or 2:30 P.M., give us three more hours to work with the students.

Chairman GLENN. Ms. Butler, are you going to be able to get the students out on Saturday for a program like that?

Ms. BUTLER. Yes, we are. In fact, we would be delighted to have the opportunity to have one of those centers in Cincinnati. What I would like to do—I wouldn't want to change your legislation. I support that we need to start in the seventh grade. But there's something about the transition from the tenth to the eleventh grade where we're losing the kids in the math and science area. So I'd like to approach possibly a little bit differently in that we would focus on those grades, eleventh and twelfth grade students, as to what we could do. I'm not nixing the idea. It's very good one.

Chairman GLENN. Very good comment.

Ms. Obara, you're in the Dublin schools?

Ms. OBARA. Yes, I am.

Chairman GLENN. You're in high school?

Ms. OBARA. Yes, I am.

Chairman GLENN. I was at the elementary school back about five or six months ago, last fall, I guess it was. The things they were doing with kids in science in the first and second grade were—I just thought they were great. They're really doing a great job. They had the kids with a heart model. These kids were in the first grade. And they had a heart model—just to digress here—they had a heart model and the kids could take it apart. But to show how it works, they had two cans representing the different chambers of the heart. Then they had these little hand pumps you squeeze, like you would cyphon gasoline with a little hand pump. And they had red water in the can. The children had to work together. One child squeezed and it would pump the red water from this can to that can. And then the other child squeezed to pump it out of the heart again. They were simulating the heart and they had to work together. One of them had to pump and then the other had to pump. They were showing me the location of where it does it in the heart. These are little first and second graders. I was quite impressed.

They had another demonstration. I think it was first grade also. It was structures research, if you want to call it that, in that they had a bunch of little egg cartons like this. They had about 100 of them there. The teacher had the kids piling up egg cartons like this [indicating]. They would get them this high [indicating], and the thing would fall over. Then, the next step was to build a base with these egg cartons like this [indicating], and then put the next level a little bit in, a little bit in, and they could build up to the same height and it was very stable. Things like that they were doing with little kids in the first grade. I wanted to stay around and play with the kids all day.

In your area, one of the problems we've had—is this mystique that girls aren't as good in math and science for some reason or another. Do you run into that every day? How do you change that message? You're trying to deal with this gender gap, and it seems to widen instead. Is it mainly just a matter of exposure and the young women get just as much confidence just by exposure to this math and science as anybody else? I noted one thing that at one of the women's universities—once they had women in an all women type setting, then women went into math and excelled in it at a higher percentage than in higher education institutions that accept both genders. Is self- confidence one of the major problems you face in this?

Ms. OBARA. Absolutely. Girls' self-confidence or self-esteem is equal to boys up until the seventh grade. 69 percent of them think pretty well of themselves equal to boys. And at the seventh grade level, girls drop down to about 29 percent think they're any good in math and science. And then we begin to get this dropout toward wanting to take these subjects. I think one of the things that helps in this camp is, besides being gee whiz, wow type of hands-on type of approach is that we have this mentor system with outstanding women. And they are going to follow these young girls.

I know myself as a teacher, when I ask youngsters to get a science project going, they don't know where to look, what to do. They don't have any ideas. "What should I do?" And this type of camp we help them find out how to do research, where. Do you go to find out about ideas and to develop them? And by having somebody to go to to ask questions that you can trust and like, that will help a lot. This even takes the place of a parent. Where parents used to help their youngsters, we now have an outstanding female that has donated 80 hours of her time for each of these 100 children. 80 hours is quite a bit of time donated free. And they will help that youngster and also take them into their place of employment, and they will get a job to do in the laboratory. If it's a chemist or physicist or whatever the scientist is, that girl will have an actual job and get an idea of what it's really like to work in a laboratory.

Chairman GLENN. Well, thank you all very, very much. It's been an interesting morning. We've been sitting here since 9:30 this morning, and I appreciate your patience in sticking with us all this time.

I don't think there's anything more important for Ohio or for our whole country, as I said earlier, than what we do with regard to education. We're not doing well compared to some other countries around the world, if some of these international tests are to be believed. And we're not going to be competitive in the future unless we do something about this. You're doing something about it in your particular instances here with some of those who are in minority status, or women and those who have not participated in the past at least as much as others in this area of math and science. Congratulations to all of you for your work in this area.

As I indicated earlier, education is taking all the past human experience of all humankind and trying to distill it into what is most important to us and then impart it to new human minds to put their own little stamp of advancement on it, and on we go into the future. It's always been thus. We seem to be having some problems

with it in our day and age, but that just means that we have to strive harder to work our way out of this, as I see it. I think we have been successful. We were the most preeminent country in the world for so long, as far as education went. Other nations are now putting as much or more emphasis in education than we are, and so we have to rise to that kind of competition. I think maybe we had—perhaps we can say we had it too easy too long in this area, and we coasted along with no one even in our league. Now others are. So we have to rise to that kind of competition if we're going to have the kind of future that we should have for this country and our state.

I think Ohio has moved forward in these areas in putting together some innovative programs compared to a lot of the other states. But we need to do more. We need to greatly increase the amount of effort.

We've had some interesting ideas here today, and I appreciate your comments and your observations today here as well as the others who were on the earlier panels and wish you well. We'll get back in touch with you on some of these things in the future. Thank you all for being here today, and as I indicated initially this morning, this is an official hearing of the United States Senate Governmental Affairs Committee. We will publish the record of the hearing and use it in our deliberations in Washington. As we review the ideas that have been given to us this morning, we will determine if legislation is needed.

We thank you very much for attending, and the hearing will stand in recess.

[Whereupon, at 1:00 p.m., the Committee was adjourned.]

APPENDIX

TESTIMONY to the COMMITTEE ON GOVERNMENTAL AFFAIRS

PROJECT DISCOVERY

Ohio's Statewide Systemic Initiative Program
in Mathematics and Science Education

Elaine H. Hairston
Chancellor
Ohio Board of Regents

NASA Lewis Research Center, Cleveland, Ohio 7/7/92

It is, indeed, a pleasure to be with you today to discuss Ohio's current mathematics and science education reform efforts. The State of Ohio and the Ohio Board of Regents have a long history of working collaboratively through K-12/higher education linkages in addressing the serious challenges facing today's students as they prepare to take their place in a society that is increasingly advanced technologically. Our world today and the one our children will provide leadership for in the future is one that demands a high level of skill in approaching and solving problems through the ability to think critically and creatively, and through the effective use of technology. It is a well documented fact that mathematics education and science education in the United States have fallen seriously behind that in other nations and Ohio is no different than her sister states in this regard. While Ohio ranks sixth among the states in science and technology-based industry and ninth in the number of small firms active in high technology, Ohio's schools rank in the mid-twenties in mathematics, science, and technology education. The need to increase the level of achievement for all

students, but especially for students from underrepresented groups who will become the majority of the next century's workforce, heightens the urgency for action if we are to prepare students to take their place in the workforce of the future.

Project Discovery, Ohio's statewide systemic initiative in math and science education, focusses on preparing middle-school students for these challenges by developing their ability to critically analyze problems and find solutions, using the principles gained in the study of mathematics and science. As such, it builds on the exemplary resources of K-12 and higher education and stands firmly on the shoulders of dedicated educators and community leaders who, fifteen years ago, were on the leading edge of the reform effort that is currently sweeping the nation.

Today, I want to give you a brief overview of Project Discovery and its importance to Ohio. But first, let me say that the success of Project Discovery is predicated on a long history of concern about the academic preparation of students in mathematics and science, and is built on the lessons we learned through past initiatives. From our early efforts, we gained a sense of some of the essential ingredients for long-term change - collaboration - strong K-12 and higher education linkages - early intervention and an investment in <u>how</u> students learn as well as <u>what</u> they learn - and finally, the importance of demystifying math and science for these young minds, replacing fear and

uncertainty with the excitement of healthy engagement with the challenges these areas of study have to offer and the confidence that comes through continuous improvement rather than continual failure.

More than fifteen years ago, we became concerned about the academic preparation of students as they were leaving high school and entering college. At that time, a concerned faculty member and a high school mathematics teacher began a dialogue that, in 1978, blossomed into the Early College Mathematics Placement Testing Program. This Program, begun as an experiment at one high school in Ohio, is now an integral part of Ohio's reform efforts in over 600 high schools and all major colleges and universities as it seeks to identify students' mathematics deficiencies in their junior year of high school -- time enough for some students to correct those deficiencies in order to enter college with a solid foundation and a greater chance for academic success. It also influences mathematics curricula revision in schools. The Program has garnered the attention of at least twenty other states who have since replicated this program. It is a successful win-win relationship between schools and colleges and done at a very low cost: $175,000 to test over 60,000 students annually.

The Early College Math Placement Testing Program stimulated a statewide dialogue between the Ohio Board of Regents and the Ohio Department of Education, and educators at all levels around the state who were generally

concerned about the success of students in making the transition from high school to college. The result was the development of a recommended course of college preparatory study so that students and educators could be clear on the minimum expectations for academic preparation as a prelude to college level work. This provided an important tool in increasing students' academic success through providing a clear sense of direction and opportunities for feedback between secondary education and the college experience. It became yet another cornerstone in Ohio's reform efforts.

As you can see, early intervention initiatives in the areas of mathematics and science education, and generally in educational reform, focussed on high school to college transition. These efforts are essential. However, they do not sufficiently address the ever deepening concerns we all share about the preparation of students in math and science. If we are to truly shape the future and prepare today's students for tomorrow's workplace challenges, we must reach young minds early in their formative educational years and transform the way students -- and teachers -- approach math and science education. We must demystify the learning process and fully engage students in how one critically analyzes problems -- providing them opportunities to find out for themselves how and why things work and to allow them to become experts in taking knowledge gained through classroom and lab experiences into other arenas -- a skill that will not only enhance their mathematics and science ability, but one that has far-

reaching impact in all academic disciplines and will source their ability to provide effective and informed leadership and inspire future technological advances that will be essential in ensuring a competitive advantage for our state and nation.

Through the federal funding provided by the Dwight D. Eisenhower Programs in Mathematics and Science Education, we were able to begin to set the wheels of change in motion and stimulate elementary and secondary school teachers, in collaboration with colleagues at colleges and universities across the state, to design the kind of learning experiences that would excite and challenge young students while providing them with the necessary academic support to be successful in their endeavors. These efforts have been further enhanced through such programs as the Teacher Leadership Consortium, an initiative funded through the Ford Foundation and the Cleveland Foundation that focusses on the professional development of the teacher and, specifically, on bringing colleges of education across the state together in designing efforts to increase the number of minorities recruited, graduated and retained as teachers in Ohio.

As you can see, the improvement of mathematics and science education is and has been a priority in Ohio and with the Ohio Board of Regents. When the call for programs came from the National Science Foundation in 1990, we were ready to respond to the request to develop a statewide systemic initiative in the area of mathematics and science education. We had learned the importance of

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collaboration and early intervention through our past efforts. We had learned the importance of providing young students new kinds of learning experiences and invigorating learning environments. We had learned the value of developing teachers to design these kinds of experiences and the importance of increasing the number of minorities and women educators as a prelude to encouraging the flow of these underrepresented groups into the mathematics and science pipeline. We had learned how to join hands with our K-12 colleagues for effective change. It was time for us to take what we had learned and move from the level of the individual classroom or teacher into effective systemic change across the system -- change that would ultimately reach into every science and mathematics classroom across the state. The National Science Foundation Statewide Systemic Initiative provided us with the opportunity to develop this kind of system-wide change and thus, Project Discovery was born.

The past two years have been very exciting for us. We were extremely pleased to be one of the first ten states awarded funds through NSF for this kind of venture. Project Discovery represents a major turning point in our history of efforts to effect change in mathematics and science education. Through available funding, our previous initiatives were only able to provide short-term interventions and locally-based programs such as workshops to enhance classroom teaching techniques or curriculum design in an specific classroom or school system. The NSF funding opportunity challenged us to define a more

comprehensive, statewide and long-term approach to improve the teaching of mathematics and science.

Project Discovery provides us with the opportunity to integrate many of Ohio's existing initiatives, resources and personnel and provide a comprehensive approach in working toward a common goal. Instead of isolated initiatives which address an individual teacher, school or issue, we were challenged to bring together diverse groups of teachers, educators, administrators, faculty, legislators, parents, students and community leaders to collaboratively define problems and design strategies and structures that would be broad-based and sustaining -- coordinated at a statewide level, but based in local communities. Let me caution that the orchestration for change is not easy, but then nothing worth having usually is.

In its early phases, Project Discovery is focussing on the training of existing middle school teachers through professional development activities in mathematics, science, and in the teaching/learning process itself. These teachers will then take that knowledge into the classroom as they design experiences for students that will encourage the student to learn mathematics and science by doing mathematics and science and discovering for themselves how and why things work. We expect that one of the outcomes of this project will be that students graduating from middle/junior high school and entering any high school curriculum -- be that college preparatory or vocational/technical education -- will have a basic scientific and mathematical literacy and will have a significantly

enhanced ability to succeed in any relevant mathematics, science or technical course and, in fact, will have an excitement and enthusiasm for mathematics and science. They will be confident learners.

Integral to Project Discovery is the concept of collaboration and partnership. We are fortunate to have committed leadership of unparalleled strength at the statewide level through the efforts of the project's principal investigators and project directors: Dr. Kenneth Wilson, Nobel Laureate in Physics and Professor at The Ohio State University; Dr. Jane Butler Kahle, a leading international scholar in science education at Miami University; Dr. E. Garrison Walters, Vice Chancellor at the Ohio Board of Regents; and Dr. Nancy Eberhart, Director of the Division of Curriculum and Instruction and Professional Development at the Ohio Department of Education. Governor Voinovich, Dr. Ted Sanders, State Superintendent of Public Instruction and I have also pledged full support of the Project. The real heros in this project, however, are the committed parents, teachers, legislators, community leaders, and students who take these innovative approaches to teaching science into the classroom and who will join together in designing efforts to address the specific needs of their particular region of the state.

Project Discovery has provided a mechanism for different sectors to work together, rather than in isolation, to define issues and design solution strategies.

It has become the catalyst bringing diverse groups together with a common goal. It has encouraged the creation of new linkages and solidified others. Most importantly, it has brought the K-12 and higher education sectors together to create an infrastructure that will encourage solutions across boundaries. This regionally-based structure helps other funded initiatives to work together through Project Discovery to maximize the use of financial resources and share professional expertise. Project Discovery has also provided a mechanism for increasing the public awareness of the fundamental importance of mathematics and science to the nation's current and future standard of living -- a strategy that will not only serve today's students, but the students of tomorrow as well.

We feel fortunate in Ohio to have received this generous grant from the National Science Foundation and urge that such programs be continued. However, the problems facing our schools are deep-seated and serious. They cannot be fixed by one project with five-year funding. Systemic change will occur only with the help of all stakeholders working together and through long-term efforts. Collaboration is time-consuming and sometimes difficult, but well worth the price in creating strategic and innovative approaches in finding solutions to the concerns we all share for Ohio's future and the future of our nation in preparing students for the challenges they will face. I applaud the NSF on its bold approach to reform in mathematics and science and urge that broad-

reaching initiatives such as the State Systemic Initiatives Program be encouraged and supported so that our students can be at the top in mathematics and science by the year 2000.

I would be pleased to answer any questions you may have.

A National Plan for Overall Educational Reform

Kenneth G. Wilson

Project Discovery†

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EXECUTIVE SUMMARY

Educational reform has been a major activity throughout the 1980's in the U.S., both at grass roots and statewide levels. However, the central question, "What to do about our educational system?" has not yet been answered. This question is still open because the massive scale of our educational enterprise (including schools, colleges, and universities) overwhelms all the current efforts at reform. More importantly, many highly capable educators have known for thirty years that our educational system has fundamental weaknesses and have dedicated their lives to try to overcome these weaknesses. Unfortunately, their energies have been exhausted bringing reform to at most a few schools. Furthermore, most reforms attempted throughout the last thirty years have failed to last. These efforts demonstrate the very difficult challenge that reform presents. Meanwhile, increasing numbers of new entrants to the workforce fall woefully short of the education needed for their life as adults and for jobs in today's economy.

†Supported in part by the National Science Foundation Program of Statewide Systemic Initiatives in Mathematics and Science Education and in part by the State of Ohio Board of Regents and Board of Education. This paper is NOT a description of Project Discovery. Project Discovery is restricted to Ohio and to mathematics and science only.

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At the heart of our problem is the typical teacher in a typical classroom with twenty to thirty-five students. Very little education currently takes place in this class. The reason for this is that students who still come to class bring many problems with them which interfere with learning. Teachers are too underprepared and overworked to cope with these problems and engage the students in learning, too. Efforts to support these teachers through professional development and school restructuring have fallen far short of the need.

Everyone in current reform is missing a full understanding of our present educational system and why it does not support individual teachers. For example, what many people do not realize is that the failure of most U.S. schools is not simply a failure to provide adequate content in mathematics and science or other subjects. The art of writing, the art of problem-solving, the art of coping with life in an organization, and other arts are missing from most (not all) classrooms, too. Assessment of these arts is absent from today's standardized tests. Not surprisingly, many adults in the U.S. (including many educators) are inexpert at these arts, which is one contributing cause of teachers' problems in schools.

The U.S. has nine powerful resources for solving the problems of a typical school or college classroom, none of which are adequately incorporated into current planning for reform. Firstly, there are five underutilized resources for classroom teaching. They are as follows:

1. The many exceptional teachers, principals, and superintendents whose expertise enables them to cope with problems which many of their peers find hopeless.
2. Students and their ability to take on responsibilities including teaching each other, both in and out of school.
3. The treasure chest of reforms already underway, with those having a long track record being especially valuable.
4. The accumulating storehouse of research knowledge about education and learning.
5. The ongoing technological revolution in computers, electronic communications, and information handling.

There are four more resources that could benefit reform:

1. The majority of over two million practicing U.S. teachers and what they could accomplish if they had access to intensive, long-term professional development.
2. The process of research, development, and product redesign widely used in industry that has met conflicting specifications for advances in performance and lowered unit costs simultaneously.
3. The large total operating budget for K-12 education in the U.S., over 200 billion dollars per year, and, in particular, the opportunities to achieve economies of scale in the costs of reform because of this large amount.
4. The political power of educational reformers throughout the U.S., if they were to unite behind a single overall plan for reform.

The classroom resources can be used to meet two distinct goals. One is to improve the quality of instruction; the other is to leverage a teacher's own teaching efforts with various other elements of teaching and learning. An essential assertion of this paper is that a complex research, development and redesign organization (RDR) is needed to help sort through the very large number of options these resources provide and make the most promising options available to individual teachers (including professors). Just to start with, the craft knowledge of tens of thousands of exemplary teachers nationwide has to be identified and evaluated, which is already too big a task for individual teachers or schools to carry out. Options identified by an RDR organization are needed to help teachers in areas such as:

- quick recognition and diagnosis of student problems
- quick recognition and constant nurturing of student talents
- achieving highly overlapping instruction in content areas and the arts mentioned earlier
- encouraging and evaluating originality in students rather than demanding standard answers
- obtaining access to materials (including software) that have been repeatedly redesigned to maximize their usefulness in the classroom rather

- extending mastery of subject matter
- encouraging students to study in groups outside school
- providng encouragement to all students regardless of gender, race, or handicap.

To ensure that this help is fully accessible for teachers, at least an hour a day of professional development is called for in this paper. Providing this help is a challenge even for a large RDR organization devoted to the task; it can overwhelm the capabilities of any university group or non-profit organization, and current professional development rarely achieves these objectives.

For overall reform to work, virtually everyone engaged in education, no matter what their role (e.g., teacher or professor, principal or department chairman, or an outside reformer), needs to change the way they spend their days. For everyone in every role, there is a set of unused resources to call on to make these changes, always headed up by exemplary peers in the same role.

For everyone involved, professional development is needed to provide a triple win. Namely, they have to learn:

- how to spend their time more wisely
- how to leverage their own time by gaining help from currently unused resources (human or otherwise)
- how to be effective participants in overall change.

This triple win I believe could become so powerful that everyone could afford to make room in their existing workday schedules for professional development. To be precise, all parties could become sufficiently more efficient so that their organization could afford to pay the supplier of professional development and release time for professional development from the savings achieved through extra efficiency.

The reform plan in this paper is based on an extensive diagnosis of overall problems of the current system reinforced by extensive references to the existing literature on failure of past reform

efforts (for example by Seymour Sarason and Michael Fullan) and observations of current reforms. The reform plan includes a plan for the study of overall reform by all parties that have to "buy into" an overall plan. The goal of the study is to build a unified society of reformers nationwide with an accepted single process of reform and political muscle to ensure that the reform process is carried out to eliminate self-defeating cultures of education.

The reform plan in this paper involves the restructuring of existing educational institutions followed by professional development throughout these institutions. The reform plan also involves the growth of a new nationally competitive market of suppliers to schools, colleges, and universities. These suppliers will facilitate restructuring or offer professional development while another independent set of firms will supply evaluation services. All firms will develop RDR organizations to improve their services. RDR organizations would collect information on craft practices, build materials and software, and conduct extensive classroom trials and evaluations.

A subsidy plan would ensure that the RDR firms initially provide intensive services to a few schools rather than dilute their offerings among many schools. The industrial redesign process benefits from far more feedback from teachers and students than either university or government laboratory programs can achieve.

Reform will reach all schools in time by a process of market growth to saturation. The RDR organizations that survive market competition will grow steadily in size which will enable them to carry out ever larger redesign projects fueled by a growing customer base among schools. The plan assumes that the market is close to self-supporting after a start-up phase, and that there is no need for a large increase in school operating costs. See the text for discussion.

The bottleneck that will slow the development of the RDR institutions is the lack of talented people with thorough training in educational research and evaluation. Therefore, initially a core of trained leaders must be developed. A staged process of development is proposed that includes a start-up phase during which incipient RDR and evaluation firms work with a few schools with the help of heavy subsidies. This start-up phase will require a major build-up of educational research groups in research universities, both to prepare human resources to staff the start-ups and to

provide an expanding research base, including research-based professional development to seed market growth. Some respected faculty in content areas will need strong incentives to make mid-career switches to educational research. Those incentives need to include multi-year career development grants and support for the build-up of a research grant program which assures stable funding for well-planned projects. These faculty would collaborate with strengthened research programs in education and social sciences. During this phase, university-based teacher enhancement programs will focus on long-term programs for small numbers of teachers, where the goal is to demonstrate that teachers can achieve a double win of wise use and leverage of instructional time, thereby establishing a basis for commercially successful professional development serving schools. Content standards will be phased in with professional development in order to reward teachers who take advantage of the already existing programs of professional development rather than causing teachers to be demoralized by standards that are out of reach. Standards will be defined to allow for educational diversity in scientific areas, foreign languages, and combinations of these disciplines that are in short supply. Standardized tests would be replaced in part by milestone projects that test students' capabilities in arts as well as understanding of content. A "backward migration" plan (e.g., initially setting standards at the highest grade level to be assessed) allows science standards to be established and implemented in higher grades without depending on standards already being met in lower grades.

The extreme specialization of university faculty causes many problems and is a barrier to educational reform. A change to the design of a university is recommended, namely a new top academic rank is added called "university professor" which would have a breadth requirement. All full professors would receive support to try to meet this requirement for further promotion.

In this plan, the question "What to do about our education system?" is answered. The primary cause of our current problems is the absence of a multibillion dollar industrial research and development sector serving educational needs. Reform would be achieved through a system of new institutions which would greatly build up major RDR organizations and enhance and coordinate current piecemeal efforts of individual reformers. Individual teachers will no longer be

reinventing old solutions to their teaching problems, or coping with recycled reform fads. Instead, a growing body of research knowledge and exemplary practices will fuel a continuous upgrading of U.S. education. However, the task of converting this paper vision of reform into actual human systems engaging millions of people remains awesome.

Bullets for Testimony of K. G. Wilson on Discovery

1. Discovery itself is off to a rousing start with teacher workshops already underway
2. The problems of education in the inner city are far from hopeless. I have seen this personally in a visit to a Chapter I "Success For All" school in Baltimore, a program of "whole school restructuring" established by Robert Slavin.
3. Discovery itself cannot support whole school restructuring efforts.
4. What Discovery needs now is an overall systemic reform effort, minimally supporting Slavin and others who are building expertise everyone needs.
5. But first, Discovery needs a diagnosis of why the present system fails, based on evidence (analogous to airplane crash evidence from a black box).
6. A modest set-aside from Chapter I could finance an overall systemic reform effort for Chapter I schools.
5. The set-aside should also support
   - support for staff to disseminate effective restructurings
   - professional development of teachers in restructured schools
   - an independent evaluation system covering all promising reforms.
6. A powerful constituency is needed to support the set-aside, similar to the constituency backing the new Mathematics standards of the NCTM. An existing independent commission reviewing Chapter I provides a start.
7. The set-aside is a logical place to experiment with Total Quality Management.
8. Educators claim that quality costs extra. But in commercial markets, high-quality services are typically obtained along with LOWERED costs by massive investments in industrial research, development, and repeated product redesign. It is time to use the same process to help achieve the National Goals for Education.

The Ohio Discovery Project and Overall Systemic Reform

Testimony to the Government Operations Committee of the U. S. Senate, July 7, 1992.

Submitted by Kenneth G. Wilson, Hazel C. Youngberg Trustees Distinguished Professor, The Ohio State University.

Address: Smith Laboratory, The Ohio State University, 174 West 18th Avenue, Columbus, Ohio, 43210, tel 614 292 8686, fax 614 292 3221

I am honored to be asked to testify about the Discovery Project in Mathematics and Science Education in Ohio funded by the National Science Foundation in its Statewide Systemic Initiatives Program. You have asked that I focus on further needs from Federal agencies for the project to succeed.

I am a co-Principal Investigator for the project along with Jane Butler Kahle of Miami University of Ohio. E. Garrison Walters of the Ohio Board of Regents and Nancy Eberhart of the Ohio Department of Education serve as co-Project Directors with us.

An Executive Summary of the Discovery Project is enclosed.

The Discovery Project builds on major previous successes in educational reform in the State of Ohio. Two statewide projects provided special inspiration for us. Reading Recovery, a program of early intervention for first graders at risk of failure in reading, is now in fory-two states, and the Early Mathematics Placement Testing Program has also been widely copied in other states. In addition, as a relative newcomer to Ohio, I have found that there is more savvy among educational reformers in Ohio than any other state I have dealt with.

The Discovery Project itself has built up remarkably quickly in the ten months since the beginning of NSF funding for the project. We are ahead of schedule and holding to our budget. Collaborations are now building in all eight regions spanning the state. Two regions have already selected leadership teams who are now into their year of training preparatory to helping to establish regional centers for mathematics and science education in their regions. The Northeast teams are currently at The Ohio State University participating in a six weeks long summer workshop for middle school teachers that they will themselves offer a year from

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tow. The West region teams are similarly engaged at Miami University of Ohio. Eighty classroom teachers are participating in this year's summer workshops; over the next four years this number will grow at least five-fold as the regions start up their own workshops.

Most gratifying to me personally has been the extraordinary outpouring of support for the Discovery project, from Governor Voinovich and the State Legislature (providing new money to match the NSF grant despite severe budget shortfalls) to the dedicated grass roots support in the regions. The Discovery staff has worked long and hard to meet the high expectations around the state that Discovery has generated.

I now turn to the issue of further Federal support needed for Discovery to succeed. I will give you my personal views on this issue: I am not speaking for Discovery or any other organization. My views have been shaped by a year of investigation and reading and participation in a National Academy of Sciences study to be mentioned later.

I believe the long term success of Discovery is heavily dependent on expanding support to overall systemic change in our school system. The reason for this is that the staffs of many schools, especially in inner city surroundings, are overwhelmed by the problems they face. It is very difficult for individual teachers, of mathematics and science or anything else, to cope with these problems in isolation. Overall systemic change is needed to enable teachers throughout a school to set common learning goals for their students and then work collaboratively to see that these goals are achieved. This kind of change cannot be achieved in the Discovery project itself because we have no mandate or funding to extend our efforts outside of mathematics and science.

I am happy to be testifying to the Government Operations Committee because I see the problem of overall systemic change as not a problem demanding new money, at least for the next few years. Instead I think it is more important to redirect a modest fraction of some current major educational programs of the Government to support overall change, and I will discuss the example of the Chapter 1 program for disadvantaged students. This program is currently funded at over one hundred times the total funding for Discovery and the other

twenty Statewide Systemic Initiatives combined. At present the bulk of Chapter I funding, despite the best efforts of all persons involved, is not addressing root problems of the unsatisfactory status quo in Chapter I schools. It is hard for Discovery to succeed when it has a hundred to one funding disadvantage against a program such as Chapter I which is not already achieving the change that Discovery is asked to produce.

I will be precise on the problem that is not being addressed through Chapter I. There seems to be a comprehensive lack of expertise in most inner city schools to recognize and overcome the deep problems they face, and the problem with Chapter I is it rarely helps teachers to acquire the expertise they need to be successful, as success is now defined (for example, by the National Goals for Education).

In my own search for the expertise that could resolve this problem, I visited the Bernard Harris Elementary School in a disadvantaged neighborhood of Baltimore. Bernard Harris is one of over thirty Chapter I schools implementing Success For All, a "whole school restructuring" program developed by Robert Slavin of Johns Hopkins University with many collaborators. What I saw at Bernard Harris gives the lie to pessimists who believe that inner city children are too stifled by problems in their environment to take an interest or succeed in academic endeavors. I saw these children glued to their books or reading to each other and all the while exhibiting exemplary discipline. I was able to read the "Parent Support Team" manual of Success For All which describes how teachers can collaborate with other professionals to build parental support for their children in school, resolve attendance and health problems, and cope with extreme discipline problems. These are all issues that underlie the hopelessness that many people feel about inner city education, and the manual summarizes a lot of know-how that is not in the hands of teachers at non- Success For All schools but also requires a strong collaborative culture to be established in a school, which is rarely the case unless a specific restructuring plan has been implemented in a school.

While I visited only Success For All, it seems clear from my studies that there are a number of school restructuring programs with similar achievements, including James Comer's

School Development Program, Ted Sizer's Coalition of Essential Schools, Henry Levin's Accelerated Schools, and a program organized by a non-profit company called Ventures in Education.

In conversations with experts on school restructuring, it is clear at least to me that these programs are still at the early stages of developing the expertise that will be needed for overall systemic change supporting the Discovery Project. In particular teachers in the program I visited still have too many classes in a day and too little professional development to be able to meet the strict educational needs of the National Goals.

I think what Discovery needs as a minimal companion effort in overall systemic reform is for Slavin's group and other well-established restructuring programs to be able to select one or more schools in their program to receive extra help. In return these schools would agree to try out alternative ways of structuring the school day or week so that it includes more time for professional development and lesson preparation and less time spent in class. In particular, since the National Goal relevant for Discovery is to be "first in the world", it is crucial that we be able to offer our teachers as much professional development and lesson preparation time as our teachers' competitors in Japan and throughout the Far East receive. As Stevenson and Stigler have documented in their book The Learning Gap, Far Eastern teachers mostly spend only three hours a day in their classes, and benefit from a remarkably effective program of collaborative study of the practice of teaching which they carry out throughout their careers. But there is another equally important need for Discovery, and that is to be able to abandon the traditional educator's claim that high educational quality automatically requires more money: to support smaller class sizes as well as shortened class schedules and more time for professional development. Instead (in a separate paper; an executive summary of it is enclosed) I have identified NINE resources for educational reform which presently GO TO WASTE because of our exclusive focus on issues involving school budgets and the time of teachers, both of which are scarce resources especially in today's cruel budget climate. What Discovery needs is the trying out of alternative schemes to make use of these nine (or other) resources to reduce

educational costs in both dollars and the time of paid staff while still improving the quality of education until the National Goals are achieved.

My recommendation to you is that there be a modest set-aside in the Chapter I program to support trying out of ideas for improving whole school restructuring to meet the twin goals of higher educational quality and lowered dollar costs. Initially the set-aside could be a few percent of the total Chapter I budget. More generally it should support efforts to build more expertise than now exists to provide education in poverty-stricken environments. The money should be directed to the small number of people who can spend it most wisely, and for Discovery's needs the whole school restructuring programs are prime candidates for this support.

There are other needs for the set-aside. One is to build an independent evaluation infrastructure that would provide arms-length evaluation of programs funded through the set-aside as well as other claimed exemplary reforms. Such arms-length evaluations are very difficult to come by today. A second need is to support the strengthening of the core staff of successfully evaluated programs so that they can help more schools take advantage of these programs. Finally there is a need to support increased professional development of teachers working in restructured Chapter I schools. All these needs are important for the success of Discovery.

A simple set-aside is not enough. There is a need to build a strong constituency backing the set-aside program and ensuring that it focuses on long term school-based research and development efforts capable of convincing and powerful advances. Unfortunately, Administrations come and go, and tend to be disdainful of programs begun before they took office. There is already an independent commission looking into the needs of the Chapter I program, funded by the MacArthur Foundation and staffed in part by David Hornbeck Associates, that is starting to build this constituency. This constituency might be expanded to include many of the organizations that already support the new NCTM standards in mathematics.

A recent National Academy of Sciences report entitled Research and Educational Reform gives a balanced overview of the sorry state of current federal funding for educational research and development. I recommend that this report be consulting in any planning for a set-aside, which would likely have a broader mandate than just to support restructuring programs. The report addresses the need to rebuild the Office of Educational Research and Improvement in the U. S. Department of Education, which unfortunately will require new money to be successful. I have concentrated here on the possibilities of the Chapter I program because I believe that is a more likely source of a successful overall systemic change initiative focussed on Chapter I schools, where Discovery's greatest challenges lie.

One cannot enter most schools without sensing that one is taking a step backwards into the late nineteenth century. Desks face front where the teacher's desk sits. There is no telephone or other evidence of modern life. Why this stark contrast to the world of business and other professions? I think the answer is very direct. The U. S. has invested hundreds of billions of dollars in industrial research, development, and repeated product redesigns in order to achieve universal availability of many twentieth century products, from electricity to telephone communications to air and automobile transportation, to computers of all kinds. In every case, the immense investment has led to products which, after many redesigns, are of much higher quality and usefulness than the original inventions which seeded each industry. Nevertheless the redesigns are also far more cost effective than the original invention. To make the point, imagine trying to get from New York to San Francisco using a World War I vintage plane, compared to jumping onto a jet today. Think also of the immense investment and accumulation of experience that guides today's air transportation employees, from design engineers to reservation clerks to air traffic controllers. NO COMPARABLE INVESTMENT has ever been made to redesign programs within U. S. education. All the reform programs one encounters, including Success For All, are only modestly beyond the Wright Brothers stage. To my knowledge, no educational program has been redesigned even to the DC-3 level, let alone the level of a Boeing 747. My recommendation is that we start making this investment with the

set-aside, and that we look for the same returns in both quality improvement and cost reductions over time that have been achieved in many commercial sectors through redesign.

At the present time, Total Quality Management is being introduced into many areas of the economy to continue the process of improving quality while reducing costs, following its highly successful use in Japan. Total Quality Management cannot simply be mandated for the central issues of education: curriculum and instruction, because it requires massive changes in the way that education is provided in the U. S., although the whole school restructuring projects rest on principles similar to the principles of Total Quality Management. A strong investment in educational research and development such as I advocate could help to provide the know-how that is needed to introduce Total Quality Management to education, and this could easily be one of the goals for the set-aside program.

The systemic reform movement in education is still very new, and many people engaged in reform are pursuing individual add-on programs rather than being part of the systemic change movement. These programs range from summer workshops that last a few years to all kinds of local business-education partnerships. In my view, the system does have grave weaknesses which no amount of add-on programs can fix, and instead we now have to arrive at a correct diagnosis of what are the root causes of failure with the present system and then fix these root causes. I would hope that many participants in add-on projects would also see that we have a systemic problem and join the effort to give systemic change top priority for limited funding.

There is a very important caution to mention. The diagnosis of failure in a complicated system is no easy task, whether the system is as familiar as a car that will not start or as exotic as the Challenger shuttle that exploded. There are complex human systems whose failures can only be diagnosed by experts: consider the case of airplane crashes, where the causes can lie anywhere in the airline transportation system, from mechanical problems with an aircraft to the procedures pilots follow to check for ice on the wings. Nevertheless we have crack crash investigation teams that are expected to find the root causes of most crashes and recommend

appropriate fixes to prevent a recurrence. In contrast, there have been literally hundreds of commissions that have tried to analyze the failure of our educational system since the publication of A Nation at Risk. One of the more honest of these reports- a National Academy of Sciences report on Biology Education called Fulfilling the Promise -admitted that the cause of failure remains a mystery. One task for your Committee might be, in the spirit of Total Quality Management applied to the whole educational system, to insist that a careful study be made of all the different candidates to be a diagnosis of failure of our educational system, and recommend a process of elimination to pin down the correct cause of failure. (These candidates range from the claims that "The American Public does not value education enough" to "present day students have no discipline anymore" to "parents lack a choice of schools for their children" to my own nominees, namely that we lack an in-service education system on the Japanese model and that we lack an industrial research and development sector to repeatedly redesign key educational programs like Success For All.) Unfortunately, up to now the task of diagnosis has been handled as a political power issue rather than a puzzle to be solved by gathering and sifting through evidence.

In conclusion, I hope the experience of starting the Statewide Systemic Initiatives and Discovery in particular can pave the way for a far more powerful program addressing overall systemic reform, based perhaps on the Chapter 1 program. Such a companion program to the Statewide Systemic Initiatives could greatly enhance the chances that Discovery and other sister projects will resolve the particular problems of mathematics and science education. I thank you again for the opportunity to address the Committee and hope you will find these remarks helpful.

The Ohio
Mathematics/Science
Project

Discovery

A National Science Foundation
Statewide Systemic Initiative

Introduction

The Ohio Mathematics/Science Project Discovery sponsored by the National Science Foundation and the State of Ohio proposes to improve the quality of the teaching and learning of mathematics and science through research-based, long-term professional development for practicing teachers. The objective is to create long-term systemic reform through partnerships of teachers, school systems, parents, institutions of higher education, community leaders as well as representatives of business and industry, foundations, and national, state and regional organizations.

The principal investigators, Dr. Kenneth Wilson and Dr. Jane Butler Kahle, provide the scaffolding of excellence from which the project is built. Professor Wilson, a Nobel laureate in Physics and the Hazel C. Youngberg Trustees Distinguished Professor at The Ohio State University, contributes the knowledge and experience of one who has been eminently successful on the frontiers of science. Jane Butler Kahle, Professor of Zoology and Condit Professor of Science Education at Miami University, is an internationally known scholar in science education. Her research experience provides insights and strategies to encourage the participation of women and minorities in science, and to translate reform into instructional change.

Professional development includes three elements: 1) an inquiry-based science or mathematics content curriculum for teachers; 2) instruction in inquiry-based teaching and cooperative learning; and 3) sustained professional development and continuing support. To enhance this development, experts in the fields of mathematics and science will work with teachers to improve the structure of mathematics and science education. The professional development elements are based on the results of research on how students learn science and mathematics. Results of this research call for revolutionary change in the entire educational system.

The Constructivist Approach to Teaching

Historically, mathematics and science courses were used to screen or filter out the average students and to identify the best and brightest students. Now it is clear that math-

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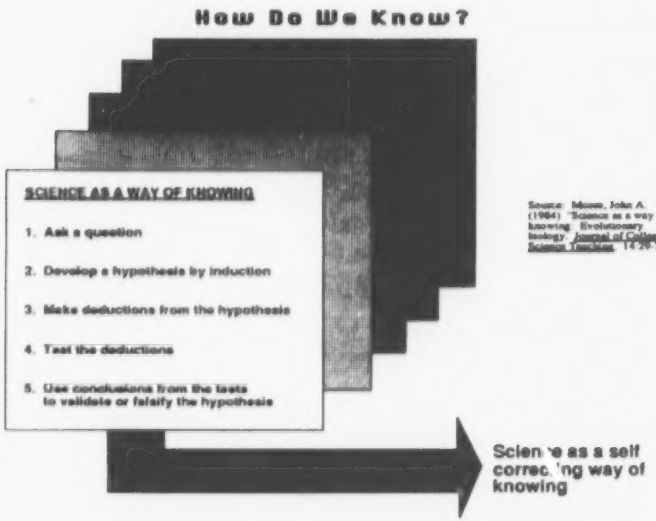
ematics and science education is needed by all students in order to achieve a basic scientific and mathematical literacy that will adequately prepare them for their entrance into college and the workforce. The constructivist model of instruction helps learners to experience the


How Do We Know?
SCIENCE AS A WAY OF KNOWING
1. Ask a question
2. Develop a hypothesis by induction
3. Make deductions from the hypothesis
4. Test the deductions
5. Use conclusions from the tests to validate or falsify the hypothesis
Science as a self correcting way of knowing

Source: Moore, John A. (1984) "Science as a way of knowing: Evolutionary biology" Journal of College Science Teaching, 14:26-32.

process of science and mathematics while they are learning about specific concepts. This involves an inquiry-based approach that requires students to question their own observations. Students study fewer topics in more depth, and they experience the frustrations of encountering and dealing with discrepant events, experimental error, missing data, and uncontrolled variables. Inquiry-based instruction further provides students with opportunities to explain their findings to others through written or oral reports and allows them to test their hypotheses through extended laboratory or field work. Faculty and staff are led

to become careful listeners and observers, encouraging students to discuss and debate points of confusion and challenging them to resolve dilemmas based on their own scientific knowledge. Requiring students to construct their own understandings of mathematical and scientific principles and to communicate those understandings to others depends on the frequent use of open-ended laboratory investigations.

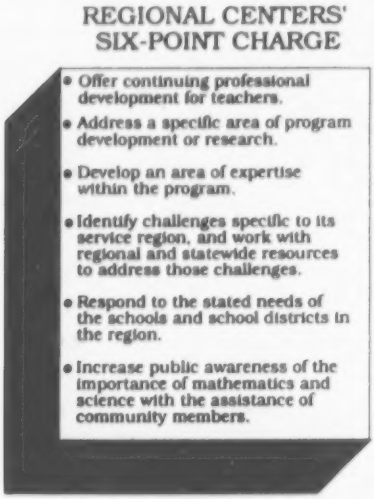
Many NSF-supported new curricular materials emphasize the integration of mathematics and science with other disciplines. By extension, the teaching and learning of mathematics and science must integrate various technologies, such as calculators and computers, that can be used to enhance students' higher order thinking skills. Inquiry-based collaborative learning, integration among disciplines and integration of technology will be a fundamental part of the inquiry-based science and mathematics courses developed for this project.

The Ohio Mathematics/Science Discovery Project

The objective of The Ohio Mathematics/Science Discovery Project is to educate Ohio's teachers in the inquiry-based method of teaching mathematics and science. Initially, two host sites, The Ohio State University and Miami University, will provide training for a selected group of exemplary middle school teachers from various regions throughout the state; eventually teachers of all grade levels will be involved. Selected teachers will be those who have strong content knowledge in mathematics and science and who are experienced in inquiry-based instruction. One discriminating aspect of The Ohio Mathematics/Science Discovery Project is that experts in the fields of mathematics and science will be involved in working with these teachers. Essentially, selected scientists will become the educators. These professionals (college or university faculty members, industrial scientists and mathematicians, master teachers, or district science or mathematics supervisors) will bring with them extensive content knowledge, teaching and research experience, and a commitment to pre-college mathematics and/or science education. They will become knowledgeable about current research in the teaching and learning of mathematics and science (nationally and internationally), will contribute new re-

search to the field, will develop curriculum and classroom materials for teachers, and will understand and address systemic issues that affect teachers in the classroom.

This primary group of scientist and mathematician/educators and teacher-leaders will participate in a summer workshop on inquiry-based instruction and will maintain interaction with the two host sites for a period of 12 months. After this initial year, the


REGIONAL CENTERS' SIX-POINT CHARGE
• Offer continuing professional development for teachers.
• Address a specific area of program development or research.
• Develop an area of expertise within the program.
• Identify challenges specific to its service region, and work with regional and statewide resources to address those challenges.
• Respond to the stated needs of the schools and school districts in the region.
• Increase public awareness of the importance of mathematics and science with the assistance of community members.

groups of scientists and teachers will assume positions equivalent to faculty at respective regional centers. The purposes of the eight regional centers are to offer content-based professional development activities and to develop local programs that will support teachers in their region. The teams of scientists and teachers will conduct continuing professional development and other regional activities for teachers. A regional center will also involve private colleges and universities, pre-service teacher education, private sector and community organizations, and interested individuals as part of its broader constituency.

Like host sites, the regional centers will employ a pattern of intensive training followed by continued contact with participants.

Sustained Systemic Network

Teachers of science and mathematics will be provided with career-long professional support for renewal, content-help, and morale. They will be backed up by links to peers who are resource teachers and then to the teams of scientists and teachers at regional centers. Continued interaction among and within program tiers will provide ongoing support beyond the residency period and will ensure that all participants are involved in quality activities that further the long-range goal of improved teaching and learning of mathematics and science throughout the educational system.

Ohio has a strong network of partners at the state, regional, and local levels that will further the implementation of this project. Additionally, the system of regional centers will result in partnerships among educators in Ohio. The structure of regional workshops and the composition of the participating teams will enhance cooperative interaction between members of the mathematics and scientific communities who are working toward the common goal of improved teaching and learning in mathematics and science. This network will not only enhance professional contact but will help project leaders maintain the quality of regional activities, identify financial resources, evaluate the progress of the program, and revise the program as state, regional, and local needs evolve. The result will be a strong cadre of scientists and mathematicians who assist one another in developing innovative strategies for the teaching and learning of mathematics and science at all grade levels.

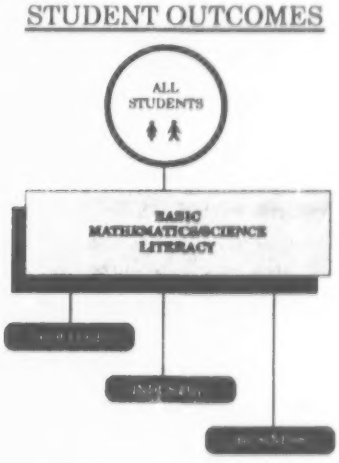
Initially, the Project leadership and state Steering Committee will assist each regional center in establishing ties with private-sector organizations in its service area. Later, community leaders, including representatives of community organizations, parent organizations, and individual parents, will form advisory boards for the regional centers and will be expected to take an active role in promoting regional and local change. Wherever appropriate, schools also will develop a volunteer network providing linkages to the commu-

nity and the local industrial base at little cost to the school system or to the program budget.

Conclusion

The student outcome expected by this central phase of The Ohio Mathematics/Science Project is that students graduating from middle/junior high school and entering any high school curriculum (college preparatory or vocational/technical education) will have a basic scientific and mathematical literacy; will be successful in any relevant mathematics, science, or technical course; will have a positive attitude toward mathematics and science; and will be adequately prepared for their role in the workforce and as informed citizens.

Project Discovery is an *active* model that builds upon decades of experimentation and success with inquiry teaching. It will provide the foundation for sustained professional development of mathematics and science teachers, bringing substantive improvement in instruction in our schools.



Ohio Mathematics/Science Project Discovery

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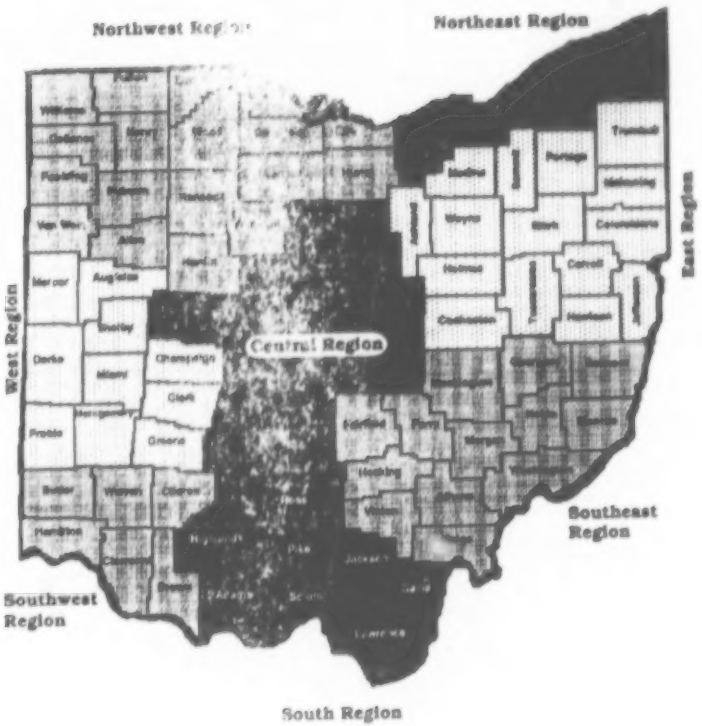
Project Discovery Regions



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Testimony of the
National Center for Science Teaching and Learning
(NCSTL)

Committee on Governmental Affairs
The Honorable Senator John Glenn, Chairman

July 7, 1992

I would first of all like to thank you, Chairman Glenn, and the other distinguished members of the committee for your invitation to appear hear today. My name is Arthur White: I am a Professor of Education at The Ohio State University, and am Director of the National Center for Science Teaching and Learning—or "NCSTL"—at OSU.

I understand that the topic of this morning's hearing is the impact of national reform efforts in science and mathematics education in the State of Ohio. I will be speaking specifically about the research efforts of the Center, and in general about our concerns regarding the research base underpinning these reform efforts, and the relationship between research and reform.

The NCSTL is one of the 23 research centers funded by the Office of Educational Research and Improvement of the U.S. Department of Education. We conduct research into what we call "external" factors affecting science education: factors outside the teachers' control which influence the teaching and learning of science. These external factors include social and cultural conditions; public incentives and perceptions; political and economic factors; the impact of new technologies; and curriculum integration (the teaching of science and mathematics as an integrated whole). The Center is in its second year of operation, and now consists of more than sixty faculty, students, and staff. Our mission statement defines our purpose and our activities: "The National Center for Science Teaching and Learning is dedicated to supporting research that will result in improvements in science teaching and learning."

To that end the Center is divided into five research focus areas: Social and Cultural Factors; Public Expectations and Societal Incentives; School Organization/Economic

and Political Forces; New Technologies; and Curriculum Integrations. The Center also has a large Evaluation component which is tasked with internal assessment of our own efforts, as well as evaluation of outside projects on a case-by-case basis.

I would like to spend just a few moments outlining the research efforts in each of these areas, and then move on to a discussion of how we perceive the relationship between research and reform.

We currently have two active projects within Focus Area 1 (Social and Cultural Factors): a study of Japanese students in Marysville, Ohio, and a study of African-American students in the Saturday Science Academy run by Clark Atlanta University in Atlanta, Georgia. In both cases, we are examining the impact of students' and teachers' cultural background on their teaching and learning styles and behavior. Our goal is to identify the factors which must be taken into account in the design of curriculum if we are to accommodate social and cultural diversity. Of particular interest in our study of students at the Clark Atlanta Saturday Science Academy is a creative writing component the Academy uses: it is our hope that the analysis of this creative writing about science will provide insight as to students' perceptions of science and the people who use science in their work.

Focus Area 2, Public Expectations and Societal Incentives, has a number of active projects, most of which concern the question of partnerships. The Center has developed two pilot projects—one matching middle school science teachers with faculty at The Ohio State University, and one studying the development of linkages between schools and the private sector—with the goal of identifying the common characteristics of successful partnerships, and developing guidelines to promote their replication.

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Focus Area 3, School Organization/Economic and Political Forces, concentrates on the effects that curriculum reform has upon the nature of schools themselves. Reform requires change and sometimes a dramatic restructuring of the way schools operate: in this area we are examining and comparing restructuring efforts in a wide range of schools across the nation: the several aspects of Focus Area 3 include studies of school restructuring in Chicago, Illinois; a variety of schools in Ohio; Texas; New Mexico; Kentucky; New York; and Maryland. Professor Robert Donmoyer, the Primary Investigator for Focus Area 3, is also working with the American Association for the Advancement of Science's Project 2061 to develop a blueprint for the school restructuring efforts which will be required by Project 2061 schools.

Focus Area 4, New Technologies, is a research and development effort focusing on computers and telecommunications. We are currently operating two projects, both concerned with developing computer-based interactive tutoring systems designed to improve science teaching. One project is headed by Professor Kenneth Wilson, of Ohio's NSF-funded Project Discovery; this project is aimed at developing systems for teaching of physics, biology, chemistry, and mathematics as part of Project Discovery's in-service teacher training component. The other main project within this focus area is developing an interactive system based on the Macintosh for use by students in the biological sciences. Finally, this fall we hope to begin a comparative study of pen-based computing and its potential for science teaching and assessment in the classroom. Our mission in this area is to determine how technological developments underway will affect curriculum and instructional reform.

The last research group, Focus Area 5, concentrates on the integration of science with other curriculum areas, primarily mathematics. The curriculum standards currently under development, and the rhetoric of many reform efforts, call for the integration of science and mathematics. However, the definition of integration is quite vague, and research is needed to characterize and categorize the various aspects of integration. Although we intuitively sense the benefits of an integrated curriculum, the actual research base is quite small: a literature review carried out by this Focus Area's primary investigator, Professor Donna Berlin of OSU's Newark Campus, found that there are only 555 total citations on integration, and that only 7% related to real research. Therefore, our goal for Focus Area 5 is to conduct research which will facilitate the development, implementation, and evaluation of integrated teaching and learning of science and mathematics.

Our overall mission, then, is research which will benefit the reform efforts. The underlying philosophy of the Center is that science educators alone should not, and indeed cannot, define science education. Science teaching and learning research must be a product of a diverse group of individuals including educators, scientists, researchers, policy makers, business and community leaders, and students. In accordance with this philosophy, the Center encourages the participation of and promotes discourse among individuals from these groups. We are therefore involved with a wide number of organizations doing work in science and mathematics education: the National Science Teachers Association; the American Association for the Advancement of Science; the National Science Foundation; the National Association for Research in Science Teaching; the American Educational Research Association; the National Council for Teachers of Mathematics; the School Science and Mathematics Association; the American Chemical Society; the Council

for Elementary Instruction; the National Association of Biology Teachers; the American Association of Physics Teachers; the National Geology Teachers Association; and many others.

As I have said, our goal at the NCSTL is research which will aid the reform effort. I emphasize that my perspective today is that of a researcher: it is my firm belief that research is crucial to the success of today's reform efforts and the success of tomorrow's schools. In order to be successful, educational reform must be based on what we know about how teaching, learning, and change itself take place in our classrooms, and this knowledge can come only from a well developed and thorough research effort. There have been several waves of educational reform in this century: in the 1920s, and in the Sputnik era, which featured curriculum efforts like BSCS, PSSC, and CHEM Study. Today we have a wealth of reform efforts: Project 2061, Science-Technology-Society, and new national curriculum standards among others. Although the reform efforts of the Sputnik Era may have been appropriate for their time, any successes they may have had have not carried forward to today. Current reform efforts are an attempt to solve problems which the reform efforts of the '20s and '60s also attempted to solve. My concern is that twenty years from now we will be facing a situation where we will be lamenting the failure of educational reform in the 1990s.

The reform movements of the past failed because they were for the most part based on intuitive notions of what would work in the classroom, rather than on definitive research. Although our current reform efforts pay greater attention to the findings of researchers, they are still not extensively based on research. This lack is partly the fault of the research community itself: the educational research base is lacking in several critical areas, and the educational research infrastructure is far too

small to meet the demand created by the current wave of reform. For example, the entire science education research community generates approximately 500 manuscripts per year, while just one of the five primary journals in biochemistry includes over 1400 articles annually.

For example, post-doctoral positions are the norm in scientific research. They provide an opportunity for advanced research training; they allow senior researchers to build research teams in order to conduct large, longitudinal research projects; and they allow the scientific community to build a large cadre of sophisticated, highly trained researchers. The federal government in the form of the National Science Foundation and the National Institutes of Health recognizes the importance of post-doctoral programs, including such them in normal grant awards as a matter of course, and funding post-doctoral and similar research positions to the tune of millions of dollars annually.

In contrast, the post-doctoral position is almost unheard of in educational research: there is little or no funding on the federal or any other level. The NCSTL currently has the funds for one post-doctoral student: it is one of few such positions in the nation. Our most limited resource is qualified personnel: we have a number of studies which have been delayed, or that we have been unable to take on, because we do not have the people to carry them out.

In a nutshell, therefore, our concern is that we are not developing the human resources necessary for the educational reform effort to succeed. The research knowledge base is too small, and too fragmented, to significantly inform reform efforts; there are not enough researchers to make a significant dent in filling these holes; and without a substantial increase in our efforts to develop qualified

personnel, we will find ourselves in the midst of another wave of reform twenty years from now. We will have too few researchers, too little research, and reform efforts which have failed to make a significant difference.

There are a number of things that can be done to expand the research base, give it greater coherence, and bridge the gap between research and practice. I would like to offer to the Committee several examples drawn from the Center's recent activities, including development of a national research agenda, the concept of action research, and our research efforts concerning partnerships.

Development of a National Research Agenda for Science Education

A critical step toward improving the science education research base is developing a national agenda for such research. The Center is working with a number of other organizations to develop this agenda, similar to that produced by the mathematics education community. It is our hope that this agenda, developed by consensus of both researchers and practitioners, will be instrumental in identifying critically needed areas of research and in channelling resources into these areas.

To this end the NCSTL has been instrumental in the formation of the Science Education Research Agenda Coalition (SERAC). The Science Education Research Agenda Coalition includes representation from AAAS, ACS, AETS, CESI, NABT, NARST, NSF, NSTA, SCST, and SSMA; there are plans to broaden this representation to several other related groups. The purpose of SERAC is to organize and coordinate research-supported efforts to improve science teaching and learning. SERAC has identified the following goals: (1) articulation of the parameters for science education research; (2) informing and actively involving both researchers and practitioners in science education research; (3) developing effective means for

the infusion of the science education research enterprise and science education research findings into science teacher education preparation (pre-service) and enhancement (in-service) programs; and (4) developing the professional posture of science education and enhancing the public perception of science education, science teachers, and science teacher education.

SERAC has developed a plan for a national research agenda and presented it as a proposal to the National Science Foundation. The proposed process includes a series of activities designed to (1) obtain input from the science education community and related stakeholders; (2) review and synthesize the appropriate literature; (3) build consensus in terms of determining what we know and what we need to know for the future; and (4) commission position papers around selected themes arising from the consensus building process. The proposal to NSF includes two conferences involving all concerned parties, which will be held at the Johnson Foundation Wingspread conference facility in Racine, Wisconsin. The NCSTL will participate collaboratively in all phases of the process, including selection of participants for conferences, selection of position paper authors, editing position papers for publication, organization of conferences, and preparation of conference proceedings for publication and distribution. It is our hope that at the end of the first stage of this ongoing process the science education community will have coalesced around a series of priorities for research.

Action Research

One of the critical challenges to the research community is to bridge the gap between research and practice, to ensure that researchers are working on problems of relevance to practitioners, and to ensure that findings are disseminated to those who can make use of them. If researchers and practitioners are engaged in an

ongoing dialogue, the systematic development of research-based knowledge should result in significant improvements in education. Important gains in research-based knowledge are made when research efforts are collaborative between teacher educators, educational researchers, and educational practitioners: classroom teachers can and should play an important role in research—the so-called action research model. In the third edition of the Handbook of Research on Teaching, a project of the American Educational Research Association, White and Tisher (1986) note that while a great deal of science education research has been conducted over the last decade, very little has affected practice. One of their suggestions to meet this challenge is for "... teachers to become full members of the [research] teams. This development may lead to a different, collaborative style wherein research is done by and with, rather than, on the teacher." (p. 897)

At its simplest, action research means involving teachers as integral components of the research team. Beyond that, it means treating teachers as professionals in a challenging and increasingly complex profession, one that requires advanced skills, the ability to meet daily challenges, and the ability to think introspectively about one's work. If through action research we can provide teachers the basic research skills they need to examine their own work, we will have successfully bridged the research/practitioner gap.

Partnerships

Action research offers one means of professionalizing teachers: partnerships between teachers and scientists or business/industry personnel can also serve to raise the professional status of the teacher, provided that partnerships are maintained on the basis of equality and shared responsibility between teacher and partner. Our preliminary research findings suggest that when teachers are provided

with financial resources for which they—not an administrator—are responsible, and when they have collaborative interaction with content and applications experts, they will perceive that their professional status , and we hope their performance, will be enhanced. Although our work is this area is still preliminary, our research concerning partnerships shows that the greatest advantage in such relationships may lie not with the outside resources *per se*, or with the curriculum which is produced, but with the changes in teachers' perceptions of themselves, and with the changes that schools make—in terms of restructuring school schedules, for example—to accommodate the suggestions of newly professionalized and empowered teachers.

I thank the Committee for its invitation to appear here today. I firmly believe that current reform efforts offer the promise a greatly improved school system, both here in the State of Ohio and nationwide; I also believe that reform's chances for success will be greatly improved if we continue to emphasize the importance of the dialogue between research and reform. The National Center for Science Teaching and Learning is looking for answers which will be of help to students, teachers, parents, and policy-makers as we all struggle to improve our schools. I and my fellow researchers stand ready to work together with you on this issue which is of such great importance to our nation's future.

Science and Mathematics Education at

The Ohio State University

I BACKGROUND

Science and mathematics education in the United States faces several related crises. The first is a poor understanding among Americans of the processes and content in science and mathematics. A second is the recent dramatic loss of college student interest in mathematics and the sciences. And a third is our failure to attract more minority and women students, a vast pool of potential talent, into mathematics and science. Each of these social problems, well documented in a variety of sources, challenge the university community. One might argue cogently, as has been done both inside and outside the university, that the university community should, for now, ignore the larger national problems while attending to the difficulties within higher education. However, there are strong arguments against this position. Since educating students for careers in the sciences, mathematics and technologies is a major responsibility of a university, declining undergraduate interest and low enrollments by minority groups and women must surely concern academics. And were we to confine ourselves to the historical science and mathematics programs within the university and remain unconcerned with education outside the campus, then our most vigorously pursued efforts would gain us little. For public awareness of science and mathematics is largely uninfluenced by present university programs. i) The majority of the public has not taken our courses; and ii) most of our students become interested or actively uninterested in science and mathematics before, not after, they become undergraduates. A second reason to consider education that occurs off the campus is the fact that 60% of college mathematics enrollments are in courses ordinarily taught in high school[1]. These courses and related remedial education place costly burdens on the universities. Finally, the public university most certainly has another important interest in public science and mathematics literacy. Insofar as the university is an important location for the education of scientists, mathematicians, and engineers, the well being of the university depends in some important part on public perceptions of these disciplines; and those perceptions are influenced by public literacy. Thus, the university community must also touch those who have not yet or who might never receive a college education. The university must reach out a science and mathematics education hand.

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[1] National Research Council, "A Report to the Nation on the Future of Mathematics Education," (National Academy Press, Washington, D.C., 1989).

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Throughout the nation universities already support successful programs that touch the needs of science and mathematics education in the community. Nonetheless, faculties of the arts and sciences and of the various technologies in universities have in the main dealt insufficiently with public science and mathematics education; we have been involved in only a peripheral manner when it comes to shaping public policy on educational issues not directly related to the university; and we have tended to ignore the educational needs of the surrounding community. We contend that to continue making significant contributions to science and mathematics education in the U.S., the faculties of American universities must participate systematically in the education of the precollege student and of the public. And we suggest that the basis of a successful systematic effort will be new programs organized within new academic structures. These new interdisciplinary programs will bind together faculty and students interested in the sciences, mathematics and education, and will help to eliminate the apparently prevalent curious notions that context and content are separable and that the educator has the expertise necessary to teach students, while scientists and mathematicians know what the student must learn.

There is also historical justification for the creation of new educational initiatives within the university. The past three decades have seen three waves of educational concern - the late Sputnik 50's, the early 70's, and the present. Three times in roughly thirty years the education of our youth has been criticized as inadequate. And each time the criticisms have dealt with the sorry state of science/mathematics education. Each time there has been a responsive flurry of activity with recruitment of academics into the primary and secondary educational arena. For it has been recognized that we must at the very least provide and enhance the content of the science and mathematics that ultimately reaches the non-university student.

All academics can applaud the present national concern over science and mathematics education. But we must also be apprehensive that today's furor will have little sustained impact at any educational level until major flaws in past reform efforts are addressed. Of concern to the university is that in the past there has been little attempt to institutionalize the university faculties participation. For example, while major infusion of funds by the NSF has successfully drawn mathematicians and scientists and into education at the primary and secondary levels, this agency has not also provided a stable environment for long-term involvement. There is the inevitable loss of federal interest and funds, after which academic efforts

cease or at best continue fitfully. Without the proper institutional shelter the long term involvement of academic scientists and mathematicians in educational research becomes problematic, but ultimate success requires continuity of effort. The stability of an institutional structure fosters this needed continuity.

In partial answer to the question of what the university can do for national science and mathematics education, the next section contains a short description of present programs within The Ohio State University. The last section describes briefly a suggestion for a systematic University approach that is under active consideration at Ohio State.

II. Present Activities at The Ohio State University

Within The Ohio State University there have been and continue to be various projects related to science/mathematics education projects. These have in large part been funded by sources outside the University with occasional significant support designated in the University budget. Because there is no central source for information on science and mathematics education at Ohio State, the true extent of such projects is unknown. For this reason, the compilation[1] included as Appendix A is an incomplete inventory. Even though incomplete, this list includes educational projects located widely around the University, with entries from the Colleges of Agriculture, Biological Sciences, Education, Engineering, Mathematical and Physical Sciences, and Medicine. We shall now briefly describe examples of these current projects. For this discussion only, there are two arbitrary categories for these activities - teacher education and student education.

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[1] That research universities such as Ohio State are engaged in comprehensive formal programs leading to academic degrees and/or certification is generally known. Therefore, the emphasis of this discussion will be on projects that are not central to the pre-service or in-service degree granting and certification programs that constitute the major programmatic efforts of the College of Education. The reader should be aware that the considerable reputation these Ohio State degree programs enjoy in large part forms the basis upon which the efforts we shall describe rest.

1. Teacher Education

a. Undergraduate Degree Programs
Programs leading to certification for teaching science and/or mathematics are housed within the College of Education. The undergraduate program in secondary science and mathematics education was developed almost 20 years ago and has attracted widespread recognition both nationally and with local school groups for its design and the effectiveness of its graduates. A similar program was developed for "post-degree" students. While we shall not describe these programs, it should be recognized that the expertise associated with these teaching efforts have been important in devising, considering and implementing new and innovative teaching methods.

b. Course Offerings
Outside of formal programs, there are science and mathematics course offerings designed specifically or otherwise appropriate for the student interested in a science/mathematics teaching career. We can consider examples from the College of Mathematical and Physical Sciences. The Mathematics Department has a list of applicable courses: 510 and 610 (Topics in Mathematics) and the series 611-615, which covers algebra, number theory and calculus. The Department of Physics offers 670 every quarter, a pre- and in-service teachers' course. The Department of Chemistry has offered (Winter quarters, 1990 & 91) the still experimental 294 - Conceptual Chemistry, directed to pre-service elementary and middle school teachers. The Department of Geology and Mineralogy offers an in-service course, 583 (Field Geology for Science Teachers) and courses at the 100-200 level that might also be appropriate for pre-service students. Field Geology for Science Teachers is an interesting model for the potential interaction between the Education college and a science academic unit. This course was started as a component of a National Science Foundation supported program for secondary science teachers. It is now one of the required courses in the undergraduate major in Earth Science Education.

c. Other Offerings
The University has a long history of effective in-service programs that address the needs of practicing teachers. These may or may not have had attached academic credit or a formal course number, and generally have been supported by funds from outside agencies such as

the NSF, the Office of Sea Grant, the Department of Energy and more recently the Dwight D. Eisenhower Program. We present here only a few examples of recent and/or current programs in science and mathematics education. *i)* A one week summer workshop for 30 high school teachers has been taught in the Department of Chemistry and supported by the Woodrow Wilson and Dreyfus Foundations. *ii)* Faculty on the Mansfield Campus have, with the aid of high school and middle school teachers, developed a Pilot Program for Middle School Science. The Martha Holden Jennings Foundation, the Richland County Foundation and the Ohio Board of Regents have provided financial support for this project. *iii)* The Mathematics Department sponsors a teachers' in-service training program funded by the NSF. *iv)* A workshop that emanates from the College of Medicine and the Biomedical Engineering Program provides instruction to teachers and student teachers in the care and use of live vertebrates in the classroom. Funding comes, in large part, from the Board of Regents. *v)* The Department of Agricultural Education receives funds from the Kellogg Foundation for an in-service training program that will team high school science and agricultural teachers. *vi)* There is a College of Education, NSF funded program to develop leadership teams for implementing earth systems education in the K-12 curriculum. *vii)* There is at the Newark Campus an Academic Challenge Program that is funded by the Ohio Board of Regents and designed to provide teachers with knowledge and experience in innovative teaching methods and materials and in conducting classroom based research.

2. Precollege student education

The Ohio Early College Mathematics Placement Testing Program (EMPT), conducted in the Department of Mathematics, is an ambitious, successful program that reaches high school students. The EMPT strategy is: i) to expose high school juniors to a mathematics placement examination similar to the one given first year students entering The Ohio State University; and then to couple this evaluation of their mathematics skills to the requirements of their intended college programs. As a result these juniors are motivated to take appropriate mathematics courses in their senior year. This program, developed at Ohio State and administered for the Ohio Board of Regents, now reaches approximately 75% of all Ohio high schools. Although EMPT

started as a remedial program, it has spawned a number of initiatives in curriculum development.

While not directed specifically to science/mathematics education, the Young Scholars Program, run from and funded in large part by the Office of Academic Affairs, has very strong science and mathematics components. Four hundred pre-7th grade low-income children from groups under-represented in higher education are inducted into this six-year program each spring. During the first year on the program, over two-thirds of their activities during a two week summer program on the Ohio State campus involves mathematics, science and computers. There is a similar academic emphasis in subsequent years of this program.

Other efforts at the University have involved smaller numbers of students and teachers on the campus. The Ross Program, funded partly by the NSF, is for gifted mathematicians of middle school to college age. Twenty "Governor's Institute for the Gifted and Talented"[3] high school students come each summer for three weeks exposure to chemistry, physics, mathematics and computer science; the Supercomputer Center started a separate one week Governor's Institute program in 1989. In recent years there have been three summer programs that place high school students in University research laboratories for most or all of summer quarter. These involve the Colleges of Medicine, Biological Sciences, Mathematics and Physical Sciences and the Office of Minority Affairs. These three programs have been funded by the NIH, the NSF, the Hughes Foundation and The Ohio State University. As a final example, the College of Engineering sponsors an Engineering Summer Academy. High school juniors have the opportunity to enroll in an entry level engineering course for which they receive college credit. This program has been successful in recruiting highly motivated students to engineering at The Ohio State University.

3. Instructional Materials and Curriculum Development

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[3] The Governor's Institute is a program that involves gifted and talented students in the arts, the sciences and engineering. It operates with State of Ohio and Ohio State University funds.

There has been significant instructional materials and curriculum development in mathematics and science education at Ohio State. In mathematics education, the production of curricular materials has been a response to teachers and schools recognizing the lack of available materials and the need to incorporate technology into mathematics instruction in natural ways. The Transition to College Mathematics project in the early 1980s developed a one year course designed for students who demonstrated lack of competency on the EMPT assessment. This innovative course incorporated daily use of the calculator to enhance mathematics teaching and learning.

The next significant curricular development activity was the Approaching Algebra Numerically project. The developed materials were designed to introduce students in grades seven and eight to the ideas of variable, function, and graph before they encountered the first formal course in algebra. Numerical problems solving activities provided a bridge between numerical ideas and the key concepts of algebra. Instruction in this case also was heavily dependent upon the use of calculator.

The most recent curricular materials development project has been directed toward incorporating graphing technology into teaching of 12th grade and beginning college precalculus mathematics. These Calculator and Computer PreCalculus (C^3PC) materials have spawned in-service work-shops for close to 600 teachers during the last few summers. The overwhelming majority of these teachers, using the C^3PC materials, have then conducted in-service education (with 41% conducting three or more) for their peers. The materials represent an effective implementation of primary, innovative ideas of the "Curriculum and Evaluation Standards for School Mathematics" of the National Council of Teachers of Mathematics. Spin-off projects concerning the teaching of calculus are now underway.

These three development activities and related in-service projects have received significant funding from Battelle, British Petroleum (SOHIO), the federal Eisenhower Program (through the Ohio Board of Regents), the National Science Foundation, and the U.S. Department of Education. In addition to faculty research, seven dissertation studies directly related to these projects have been completed and more are underway. Faculty and students at other institutions of

higher education have completed research related to and using these materials.

There have also been cooperative efforts with K-12 science curriculum materials development. These efforts started with the Crustal Evolution Education Project funded by the NSF during the mid 70's, and the development of over 25 modules through the Oceanic Education Activities for Great Lake Schools supported by the Office of Sea Grant and the University. Such projects typically involve the cooperation of scientists, science educators and teachers, and provide excellent examples of continuing projects supported by a combination of State, Federal and University funds. The following short list is a sample of such projects currently underway.

In the College of Education there is a project to develop a computer based network for teaching science and mathematics. The Columbus Public School System funds a program, in the College of Education, to develop a robotically aided environment for elementary students. In the College of Agriculture there is a State of Ohio and 4-H funded program, "The Incredible Egg", that engages 20,000 4th and 5th graders in the study of chick embryology. A program from the School of Natural Resources, "Our Backyard Biosphere Reserve", targets grades K-8 in schools of the southern Appalachian region in order to provide classroom modules dealing with the Great Smokey Mountains Park Biosphere Reserve. There is a unique cooperative effort between the Worthington High School and the College of Education to develop and implement an integrated two-year Biological and Earth Systems Science course. This program is supported with federal funds to the Worthington Schools and Eisenhower Program funds to the University. The Earth Systems Education Program, with federal and state support to the University and to local school districts, obtained a series of grants starting in 1990. This program provides national, state and local leadership for the improvement and modernization of science teaching education in grades K-12.

Development of curricular and instructional materials has served a primary role in responding to the needs of the schools and providing an extended base for research in teaching and learning. Further, this development activity has promoted in-service activities leading to significant changes in the teaching of mathematics and the sciences in today's schools.

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4. Research and Evaluation

Ohio State University faculty members have conducted well recognized science education research projects exploring: i) effective questioning strategies for science teachers; ii) alternative learning environments (e.g., museums, zoos, and natural settings); iii) accommodation of individual learning styles in the design and selection of learning activities; iv) the integration of the sciences; and v) the applications of technology to broaden and enrich the pedagogical preparation and updating of pre-service and in-service teachers. There has also been active research in concept learning, decision making, defining the domain of knowledge for environmental education, developing instruments for assessment of spatial-symbolic information processing ability, developing an action research model for teacher involvement in classroom-based research, and developing models for international collaborative research in science and mathematics teaching and learning.

An important component of educational research is evaluation of existent materials and programs. Science educators at The Ohio State University have been heavily involved in such activities. For example, the evaluation of materials produced by the NSF supported Crustal Evolution Education Project was conducted here. This uniquely designed project involved 10 sites and over 10,000 students. Another example is the long-term evaluation supported by the National Oceanic and Atmospheric Administration. This eight year project studied workshops and curricular materials that had been sponsored by the Ohio Sea Grant Education Program.

As part of a goal to monitor and enhance public information about science, the University's School of Natural Resources and the College of Education have conducted mass media research on environmental communications. Research has documented newspaper coverage of acid deposition in regions that generate precursors as compared with those that suffer from the problem. In another project, knowledge and attitude changes in individuals exposed to a single viewing of a Jaques Cousteau environmental documentary were compared qualitatively to changes resulting from a similar presentation made by a master teacher.

APPENDIX A

Inventory of Science/Mathematics Education Projects at The Ohio State University

WINTER QUARTER, 1992

INVENTORY OF SCIENCE AND MATHEMATICS

EDUCATION PROJECTS

PROGRAM: **A Course Providing Public Information for Environmental Decision Making**
DESCRIPTION: Development of a University course for the general public.
FUNDING: Ohio Environmental Protection Agency
PROFESSOR: Professor Rosanne Fortner, Natural Resources
Professor Joe Heimlich, Ohio Cooperative Extension Service

PROGRAM: **Alternative Assessments in Science & Math Education**
DESCRIPTION: Directed at approximately 120 9-12th graders, this program provides high technology-based computerized instruction in math and science as well as other areas.
FUNDING: Apple Computer
FACULTY: Professor Robert Tierney, Department of Educational Theory and Practice

PROGRAM: **Animals in the classroom**
DESCRIPTION: The animals in the classroom program has been a collaborative endeavor between The Ohio State University and The Ohio Academy of Science. It is a program of education for pre-college teachers (K-12) on the humane care and use of a animals in education and student research.
FUNDING: Ohio State University and Ohio's Board of Regents
FACULTY: Fredrick Cornhill, Director, Biomedical Engineering Center

PROGRAM: **Apple Global Education (AGE)**
DESCRIPTION: Directed at grades K-14, this program could involve up to 150 schools both in the U.S. and overseas. Those involved act as mentors teaching over phone lines with computers. The only school involved in 1990 is Marigold H.S. in Victoria, B.C.
FUNDING: The Ohio Board of Regents Academic Challenge Grant
FACULTY: Professor Marvin Bratt, Department of Educational Theory and Practice

PROGRAM: **Brain Mapping of Higher Order Mathematical Problem Solving in Spatial and Abstract Reasoning**
DESCRIPTION: Brain mapping of fifteen 8th graders in Dr. Sheffield's NSF Young Scholar's Program. Evaluation of differences in brain processing associated with high and low performance in spatial thinking and abstract reasoning. Students were also brain mapped while playing Tetris (a computer game) and comparisons made between high and low performers, males and females, etc.
FUNDING: None
FACULTY: Professor Marlin Languis, Department of Educational Theory and Practice

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Professor Linda Sheffield, Northern Kentucky University

PROGRAM **Breakthroughs in Mathematical Problem Solving**
DESCRIPTION: Supplemental materials to increase students proficiency in math problem solving. This program will benefit students and teachers
FUNDING: Ucher-Bloser Publishing Company
FACULTY: Larry Magliocca, Ed Svc & Res.

PROGRAM: **Breakthroughs: Strategy for Thinking**
DESCRIPTION: Attempts to teach thinking strategies through science curriculum context. Directed at K-8 grade teachers, this program centers on improving effective thinking.
FUNDING: Zaner-Bloser Publishing Company
FACULTY: Professor Larry Magliocca, Education Services & Resources

PROGRAM: **Calculus and Mathematics**
DESCRIPTION: Computer base course using mathematics
FUNDING: National Science Foundation
FACULTY: Professor William J. Davis, Mathematics

PROGRAM: **Collaborative Inservice in Activity-Based Science**
DESCRIPTION: The project involves an intensive two-week summer institute (5 graduate credits) with follow-up activities and course (one credit) which emphasizes understanding, planning, implementing and evaluating an inquiry, activity-based approach to elementary science.
FUNDING: The Ohio Board of Regents, OSU Newark, and Worthington City Schools
FACULTY: Professor Diane Cantrell, Department of Ed Theory/Practice

PROGRAM: **College Readiness via Technology-Enhanced Mathematics (CORTEM)**
DESCRIPTION: The project funds summer institutes designed to prepare school teachers to use a computer-and-calculator-based approach to teaching and learning mathematics. This project is directed towards teachers of grades 7-14 and encompasses approximately 150 participants.
FUNDING: Department of Education
FACULTY: Professor Alan Osborne, Department of Educational Theory and Practice Professor Bert Waits, Department of Mathematics

PROGRAM: **Curriculum Development for Earth System Science Education**
DESCRIPTION: Development of a new upper level undergraduate class, Integrated Earth Systems, which will focus upon the following four aspects of Earth Systems Science: Earth systems and their models, Earth system history, global scale observation of the Earth and socioeconomic aspects of global change. In addition, the Earth Systems Sequence, a two course, introductory level class, will

be augmented with lectures and laboratory exercises focussing upon problems of global change.
FUNDING: Universities Space Research Association (NASA) - pending
FACULTY: Professor Ellen Mosley-Thompson, Byrd Polar Research Center and Department of Geography
Professor Garry McKenzie, Department of Geology
Professor A. John Arnfield, Department of Geograph
Professor John D. Bossler, Center for Mapping and and Department of Geology
Professor Kenneth C. Jezek, Byrd Polar Research Center and Department of Geology
Professor Carolyn J. Merry, Department of Civil Engineering
Professor Richard H. Steckel, Department of Economics
Professor Lonnie G. Thompson, Byrd Polar Research Center

PROGRAM: **CIPC, Transit, and EMPT**
DESCRIPTION:
FUNDING: NSF, Department of Education, and Ohio Board of Regents
FACULTY: Professor Frank Demana, Mathematics, Ed El Thry/Prac

PROGRAM: **Development of Interactive Video for Physics Teaching**
DESCRIPTION: Computer programs are being developed to access video images from Laser disk or video tapes.
FUNDING: Department of Physics
FACULTY: Professor William Plouge, Physics

PROGRAM: **Developing a Robotically-Aided Scientific Education Laboratory for Severely Physically Disabled Elementary Students**
DESCRIPTION: Five elementary students per year will be involved in the program to develop a robotically-aided environment for scientific development for the severely handicapped child.
FUNDING: Columbus Public Schools and OSU
FACULTY: Professor Richard Howell, Department of Educational Policy and Leadership

PROGRAM: **Developing an Intelligent Tutoring System for Transfusion Medicine**
DESCRIPTION: Explore general issues in design of computer base
learning environment in the context of teaching transfusion medicine.
FUNDING: National Heart, Lung, and Blood Institute
FACULTY: Professor Phil Smith, Hlth Phs Ed & Rec

PROGRAM: **Developing an Intelligent Tutoring System for Teaching Orthopedics**
DESCRIPTION: The goal of this project is to develop a problem base learning environment for teaching analysis for teaching disorders to physical therapist & medical students.
FUNDING: U.S. Dept. of Education

FACULTY: Professor Phil Smith, Hlth Phs Ed & Rec

PROGRAM: **Dreyfus Woodrow Wilson Fellowship Foundation**
DESCRIPTION: Directed at High School Chemistry Teachers, this program provides funding for teachers for a one week class which gives them 3 hours of graduate level credit.
FUNDING: Dreyfus
FACULTY: Professor Robert Ouellette, Department of Chemistry
Mary Bailey, Department of Chemistry Instructional Aids Staff

PROGRAM: **ERIC Clearinghouse for Science, Mathematics and Environmental Education**
DESCRIPTION: The Educational Resources Information Center (ERIC) is a national information system designed to provide users with ready access to an extensive body of education-related literature. Through its 16 subject-specific clearinghouses and four support componants, it provides a variety of services and products that can help instructors stay up to date on a broad range of education-related issues.
FUNDING: The U.S. Department of Education, Office of Educational Research and Improvement
FACULTY: Professor David Haury
Studies

PROGRAM: **Eisenhower Project**
DESCRIPTION: 3 year project, serve 80 teachers a year-Math & 20 teachers
FUNDING: U.S. Office of Education
FACULTY: Professor Alan Osborne, Ed El/Thry/Prac

PROGRAM: **Focus Area III, NCSTL (Project 2061)**
DESCRIPTION: Center's Focus Area/Attempt to talk about school organizations for Project 2061.
FUNDING: NCSTL; American Association Advancement of Science
FACULTY: Professor Robert Donmoyer, Ed Policy/Ldship

PROGRAM: **Global Environmental Change in the Great Lakes: Information for Educators and Advisory Services**
DESCRIPTION: Directed to 120 teachers & advisory agents in 6 states, introducing them to new information concerning environmental changes. This focuses on environmental impacts of global changes in the Great Lakes region.
FUNDING: NOAA, The U.S. Department of Commerce, through Ohio Sea Grant College Program
FACULTY: Professor Rosanne Fortner, School of Natural Resources
Professor Victor Mayer, Department of Educational Studies

PROGRAM: **Governor's Institute (The Gifted and Talented Program)**
DESCRIPTION: Twenty middle-school students are given instruction in math, chemistry and physics during a 3 week summer program. In the physics portion of the program the institute offers a brief introduction to conceptual physics. The materials come from two college courses. The topics covered are kinematics and electric circuits as examples of physical methods.
FUNDING: State of Ohio, OSU
FACULTY: Professor Richard G. Seyler, Department of Physics
Professor Robert Ouellette, Department of Chemistry
Professor Mary Bailey, Department of Chemistry
Instructional Aids Staff

PROGRAM: **Granville-Newark-Heath-at Risk Youth Summer Education**
DESCRIPTION: This program aims to improve the mathematics and english skills of at-risk youth through remediation and work experience during the summer. This project will run through the summer of 1991.
FUNDING: Ohio Department of Education
FACULTY: Professor William Ashley, Center on Education & Training for Employment

PROGRAM: **Howard Hughes Grant for Biology Education**
DESCRIPTION: Brings black high school students to work in research laboratories in biology during the summer months. Trains high school biology teachers in new concepts and teaching methods during summer and academic year.
FUNDING: The Howard Hughes Medical Institute
FACULTY: Professor William A. Jensen, Plant Biology

PROGRAM: **Howard Hughes Medical Institute Secondary School Outreach/Administration**
DESCRIPTION: Training program for High School teacher to enrich the hands-on biology activity for students in their class.
FUNDING: Howard Hughes Medical Institute
FACULTY: Professor Dave Culver, Zoology

PROGRAM: **Howard Hughes Medical Institute Student Development & Broading Assess**
DESCRIPTION: Involves summer research experience for High School students in university laboratories.
FUNDING: Howard Hughes Medical Institute
FACULTY: Professor Dave Culver, Zoology

PROGRAM: **How do School Age Japanese Sojourners Learn Math & Science in American Schools?: Japanese or American Learning Strategies?**
DESCRIPTION: Currently involves 50 elementary and middle school students looking at how they adjust to new learning techniques.
FUNDING: Funding for this program is pending.
FACULTY: Professor Keiko Samimy, Department of Educational Studies
Professor Michael H. Klapper, Department of Chemistry

PROGRAM: **Integrative Science Technology through Cooperative Activities**
DESCRIPTION: More technology, course involves some intermixing with chemistry classes by tutoring.
FUNDING: Eisenhower Grant & Ohio Board of Regents
PROFESSOR: Professor Karen Zuga, Ed Stds:hu/Sv/V

PROGRAM: **Improving Teachers' Ability to Teach Science**
DESCRIPTION: An innovative service training program is being developed to link high school agricultural teachers with science teachers. Approximately 30 teachers (15 science and 15 agricultural education) and 3,150 high school students per year will receive instruction from OSU College of Agriculture.
FUNDING: Kellogg Foundation
FACULTY: Professor Rosemarie Rosetti, Department of Agricultural Education

PROGRAM: **Improving the Basic Skills of At-Risk Youth with Microcomputer-Based Educational Programs**
DESCRIPTION: Validate a three-part educational program model to improve the basic skills of underachieving youth (U.S.D.O.E.). This would be a continuation of a current project.
FUNDING: Funding is pending.
FACULTY: Professor William Ashley, Center on Education & Training for Employment

PROGRAM: **Integrate Science Curricular for Central Ohio Middle Schools**
DESCRIPTION: A two-year long program to work with 10 school districts in Central Ohio to develop a 3-year E Systems integrated course of study and pilot it in one school of each district.
FUNDING: Eisenhower Program (not yet approved by Board of Regents
FACULTY: Vic Mayer, Educational Studies, Ohio State University

PROGRAM: **Incredible Egg**
DESCRIPTION: This program allows 20,000 4th and 5th graders to learn about the beginning of life by studying chick embryology using hands-on activities.
FUNDING: State of Ohio and Ohio 4-H
FACULTY: Professor Robert Horton, Cooperative Extension Service

PROGRAM: **Japanese Children in American Schools.**
DESCRIPTION: Cultural Study, How Japanese children learn science and math. Comparing learning process. This is designed to benefit students and teachers.
FUNDING: The Ohio State University
FACULTY: Professor Keiko Samimy, Ed Stds:hu/Sc/V

PROGRAM: **Life Times-a weekly newsletter directed to undergraduates of biology 101 and 102.**
DESCRIPTION: TLT Publishers articles from the popular press

concerning current events in biology to show students that the need for understanding biological principles goes beyond the classroom.

FUNDING: General Biology Program
PROFESSOR: Professor Robin Taylor, Asst. Editor, General Biology

PROGRAM: **Mathematics Teaching Skills Training for OWA Instructors**
DESCRIPTION: This program is designed to reach approximately 30-50 teachers in the Cleveland, Columbus, and Cincinnati areas. Training is provided to OWA teachers to strengthen and reinforce math skills in their 9th and 10th grade educationally-disadvantaged classes.
FUNDING: The Ohio Board of Regents
FACULTY: Professor Sandra Pritz, Department on Education & Training for Employment

PROGRAM: **Microcomputer-Based Approach to Improving the Basic Math Skills of Disadvantaged and Mainstreamed Handicapped Students**
DESCRIPTION: This project was designed as a pilot test in Columbus Public Schools. The objective was to develop a set of prototype materials and assessment experiences in basic math to provide disadvantaged and handicapped students the opportunity to develop basic job-related skills and increase computer literacy (78 math skills were targeted at 31 entry level occupations).
FUNDING: U.S. Department of Education, Secretary's Discretionary Fund
FACULTY: Professor Sandra Pritz, Educational Services and Resources

PROGRAM: **Minority High School Students Summer Research Apprenticeship Program**
DESCRIPTION: Eight weeks; students work 8 hours, 5 days a week with researchers, college of Pharmacy, Medicine, Biological Science, Vet Med, Dentistry, Nursing-college. Students are paid $5.10/hr. Teachers receive $5,000 Per Teacher per summer. Public presentation for projects.
FUNDING:
PROFESSOR:

PROGRAM: **NCSTL Focus Area I - Grant proposal to NSF Teacher Preparation & Enhancement: "Teacher-centered Reform in Elementary School Science".**
DESCRIPTION: Based on the premise that teachers' beliefs are centered to practice, the project focuses on helping teachers improve their science teaching and curriculum by: 1) assisting teachers to become aware of how their views of science and technology influence their practice, 2) Supporting teachers in developing enlarged views and in incorporating these views into classroom practice, and 3) fostering teachers' research into their practice.
FUNDING: National Science Foundation/Worthington High Schools/OSU
FACULTY: Professor Barbara Reeves, 2-Social, Math & Phys Sci.

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PROGRAM: **National Center for Science Teaching and Learning**
DESCRIPTION: Research on factors external to the curriculum that influence science teaching and learning.
FUNDING: U. S. Department of Education
FACULTY: Professor Arthur White, Department of Educational Studies
Professor Michael Klapper, Department of Chemistry

PROGRAM: **Network for the Integrated Teaching and Learning of Science and Mathematics**
DESCRIPTION: This program will develop a multidisciplinary electronic network for collaborative research and development of materials and activities for the integrated teaching and learning of science and mathematics. It is directed at teachers of grades K-12.
FUNDING: NSF and School Science, Mathematics Association, Johnson Foundation
FACULTY: Professor Arthur White, Department of Educational Studies
Professor Donna Berlin, Department of Educational Theory and Practice
Professor Darrel Fyffe (Bowling Green State University, Ohio)

PROGRAM: **OBR's Eisenhower Mathematics and Science Education Program**
DESCRIPTION: This OBR program makes awards (~30 each year) to higher education for projects that serve precollege teachers and students. This program is directed at grades K- 12.
FUNDING: Ohio Board of Regents, U.S. Department of Education
FACULTY: Professor Russell Utgard

PROGRAM: **Ohio Discovery Project**
DESCRIPTION: Development of 10 regional centers throughout Ohio. Scientists/mathematicians will work with Resource Teachers, ad train them on inquiry-based math and science education. Additionally, a sustained professional network for teachers will be developed for support. This will benefit teachers.
FUNDING: National Science Foundation, 5-yr. grant matched by the State
FACULTY: Professor Ken Wilson, Physics

PROGRAM: **OSU Newark Education Academic Challenge Program**
DESCRIPTION: This is a six-year program for kindergarten through eighth grade teachers designed to : 1) provide teachers with knowledge and experiences related to innovative teaching methods and materials; 2) provide teachers with knowledge and experiences in order to conduct classroom-based research; and 3) develop, implement, evaluate, and disseminate innovative teaching methods and materials. After three years, the Program has resulted in numerous teacher-developed and teacher-evaluated innovative classroom activities that have been disseminated through an annual conference and published Proceedings.

FUNDING: The Ohio Board of Regents Academic Challenge Grant
FACULTY: Professor Donna F. Berlin, Department of Educational Theory and Practice

PROGRAM: 1990 OSU Newark Invitational Science Day Project
DESCRIPTION: This project has two phases: 1) One team consisting of 3 students and 1 teacher from each school attend a one day workshop focusing on scientific method and science fair projects. Students go back to their schools and teach other 5th & 6th grade students the experiments they learned. 2) Students who receive superior ratings at local science fairs attend OSU Newark Invitational Science Day where they attend Science programs and have their projects judged.
FUNDING: Dow Chemical U.S.A., O.S.U. Newark & Licking County Schools
FACULTY: Professor Diane Cantrell, Department of Educational Theory and Practice

PROGRAM: Our Backyard Biosphere Reserve
DESCRIPTION: This program targets grades K-8 in schools located in the Southern Appalachian Region. It provides education modules on The Great Smoky Mountains Park Biosphere Reserve as well as an environmental guide designed for student awareness of critical resource issues affecting the Southern Appalachians.
FUNDING: City of Gatlinburg, Tennessee; Great Smoky Mountains Natural History Association and the U.S. Department of State Man and Biosphere Program
FACULTY: Professor Gary Mullins, School of Natural Resources

PROGRAM: Ohio Model for Excellence & Mathematics
DESCRIPTION: Teachers & Administrators will be meeting at various sites, having meetings this year. Is a 3-year project. Focus on changes in Ohio Mass Model.
FUNDING: Eisenhower funding
FACULTY: Professor Mary Schmidt, Mansfield Campus, Ed El Thry/Prac

PROGRAM: Ohio-Mathematics/Science Discovery Project
DESCRIPTION: Establish regional centers, train staff and in-service middle school teachers of science and mathematics. Summer Institutes and academic year follow-up. This project will benefit teachers. The Ohio Mathematics/Science Discovery Project creates a framework and process for the sustained professional development of middle school and junior high school mathematics and science teachers. Working through eight regional centers, the professional development program includes a solid grounding in mathematics and science inquiry-based instruction, and experience with research strategies that assess changes in student learning. Additional research will focus on the adaptation or creation of new teaching materials that complement inquiry-based instruction.

FUNDING: National Science Foundation, Ohio State University
FACULTY: Professor Kenneth G. Wilson, Physics Department

PROGRAM: **Partnerships for Future. STEP Coalition**
DESCRIPTION: A coalition of individuals from education and industry working together to improve Math, Science & Technology education. STEP is project target for upgrading science knowledge and science teaching schools in the Columbus Middle Schools.
FUNDING: Industry, Columbus Foundation
FACULTY: Professor Shirley Heck and Professor Roger Cunningham

PROGRAM: **Partnership to make Science Teaching More of a Science**
DESCRIPTION: Development of Science Base for Secondary Schools.
FUNDING:
FACULTY: Professor Sally Rudmann, Allied Med Professional

PROGRAM: **Partnerships for the Future: Math/Science/Technology Task Force**
DESCRIPTION: This project is designed to develop partnerships between school and industry for the purpose of addressing the concerns over the quality of science, math, and technology education in the local area. Teachers and engineers try to find innovative ways to upgrade science, math and technology instruction in the classroom. Initially this is a local program with the expectation that it will expand to have broader influence in the future.
FUNDING: Batelle and other firms like AEP, Engineers Foundation of Ohio
FACULTY: Professor Roger Cunningham, Department of Educational Theory and Practice

PROGRAM: **Plant Biology Interactive Multi-Media Development Project**
DESCRIPTION: Developing computer assisted instruction cover entire quarter course. Completed chemistry of Life, compounds of life, World of the cell, DNA, RNA & Protein Synth.
FUNDING: Center for Teaching Excellence
PROFESSOR: Professor Anne Pruitt, Educ. Pol/Ldship

PROGRAM: **Program for Leadership in Earth Systems Education**
DESCRIPTION: This program is directed at grades K-12. It prepares leadership teams for implementing the Earth Systems Education within the curriculum for these grades. This national program will have involved over 5000 teachers by 1993.
FUNDING: National Science Foundation, Teacher Enhancement
FACULTY: Professor Victor Mayer, Department of Educational Studies
Professor Rosanne W. Fortner, School of Natural Resources
Professor William Hoyte, University of Northern Colorado
Professor Ellen Thompson, Geography

PROGRAM: **Project Symbiosis**
DESCRIPTION: Improved Science Instruction Via Teaming Science and Voc. Agr. Teachers together project Includes 5 Day Long Workshops.
FUNDING: Kellogg Foundation this year with some OSU Support
FACULTY: Professor James Altschuld, Educ Svcs & Res

PROGRAM: **Research Apprentice Program**
DESCRIPTION: Provides funding for 30-35 junior and senior students for an eight week summer program to encourage minorities to enter biological science, veterinary medicine, medicine, dentistry and pharmacy.
FUNDING: National Institute of Health
FACULTY: Professor Ann Ackermann-Brown, Department of Microbiology
Professor Lester Morrow, Director of Program Development/Minority Affairs Christine Yash, Medicine Administration Staff

PROGRAM: **Ross Young Scholars Program (Summers)**
DESCRIPTION: A program for talented students including minorities and under-represented groups in grades 9-12. Eager and able youngsters whose achievement is limited by the lack of adequate opportunities at school.
FUNDING: National Science Foundation provides partial funding, Department of Mathematics also supplies funding
FACULTY: Professor Arnold Ross, Department of Mathematics

PROGRAM: **Science Fun with Dairy Foods**
DESCRIPTION: Directed at home economics students, this program reaches 800 high school students. The focus of the program is on the science behind processing of dairy foods. The format is nine, easy-to-use lesson plans for making ice cream, ripening cheese, and making yogurt.
FUNDING: State of Ohio, Ohio 4-H
FACULTY: Professor Robert Horton, Cooperative Extension Service

PROGRAM: **Science is Fun**
DESCRIPTION: Designed to introduce more hands-on science in elementary/middle schools. There are three components to the program: curriculum development, teacher training, and strategy to get innovation into schools. It reaches 125 upper and middle school teachers in 24 school districts in 11 counties (~10,000 students are affected).
FUNDING: Ohio Board of Regents, Martha Holden Jennings Foundation, Richland County Foundation
FACULTY: Professor Janet Tarino, Department of Chemistry, OSU Mansfield

PROGRAM: **Science is Fun**
DESCRIPTION: Expansion of PREFACE (a bridge program directed at precollege familiarization and cooperative education).
FUNDING: Funding for this program is pending - It will be the Columbus Foundation.

FACULTY: Professor John T. Demel, Department of Engineering Graphics
Professor Janet Tarino, Department of Chemistry, OSU Mansfield
Professor Mike Burgess, Columbus State
Ms. Gloria Letts, Science Coordinator, Columbus Public Schools
Professor Roger Cunningham, Educational Policy & Leadership

PROGRAM: **Science Teaching Partnership Project**
DESCRIPTION: Provide grants to junior high school teachers. Teachers assisted by Ohio State science researchers together develop educational units for junior high school students.
FUNDING: Martha Holden Jennings Foundation
FACULTY: Professor Phillip Heath, Department of Educational Theory and Practice
Professor Michael H. Klapper, Department of Chemistry

PROGRAM: **Science-Technology Society**
DESCRIPTION: Projected to provide a series of workshops for Washington Court House Schools to enhance teaching through use of technology, instruction and current issues. This program would involve 7 junior high and high school teachers.
FUNDING: This program is not currently funded (this is an ongoing project).
FACULTY: Professor Phillip Heath, Department of Educational Theory and Practice

PROGRAM: **Secondary Science Curriculum Modules for Global Change Education**
DESCRIPTION: This program functions to prepare material on global change for senior high school students
FUNDING: National Science Foundation, Materials Development
FACULTY: Professor Victor Mayer, Department of Educational Studies
Professor Rosanne Fortner, School of Natural Resources
Professor David Elliot, Department of Geology and Mineralogy

PROGRAM: **State of Ohio Pilot Mathematics Education Coalition**
DESCRIPTION: The purpose of this coalition is to form a high level state-wide volition committee for mathematics education.
FUNDING: MSEB planning grant
FACULTY: Professor Frank Demana, Department of Mathematics

PROGRAM: **STS-Ohio (3-School Systems)**
DESCRIPTION: Three days to be used in classroom 4th, 5th, & 6th grades for at risk students; major participates 4-H people, Lima School, Ohio State University & Others.
FUNDING: U.S. Department of Agriculture
FACULTY: Professor Phil Heath, Dean, Ed El Thry/Prac

PROGRAM: **Supercomputing: Science and Art Visualizing the Future**
DESCRIPTION: Objectives: Use supercomputer, work on research team, develop skills with MacIntosh PCS, Next workstations, Sun workstations, Silicon graphics workstations and learn Pascal. Exposure to process of visualizing data.
FUNDING: Ohio State University
FACULTY: Professor Alvin E. Stutz, Asst. Dir-User Services, Ohio Supercomputer Center, The Ohio State University

PROGRAM: **Switch-On to Science**
DESCRIPTION: A summer program & follow-up activities designed to increase the interest and knowledge of middle school girls in Science & Science related areas. Program includes an intensive two week program and mentor component and additional Science activities -throughout the year.
FUNDING: Department of Education, Eisenhover
FACULTY: Carolyn Carter, Educational Studies

PROGRAM: **Technology-Informed Mathematics Education for Underrepresented Students (TIME for US)**
DESCRIPTION: This project provides school-year mathematics-related activities for the young scholars attending OSU two and three week summer institutes. The program is designed to address the growing problems of the underrepresentation of certain minority groups in higher education, particularly in mathematics and the sciences. It directed at grades 7-12 and includes approximately 300 participants.
FUNDING: National Science Foundation
FACULTY: Professor Frank Demana, Department of Mathematics
Professor James Bishop, Special Assistant to the Provost

PROGRAM: **Technology Reform and Network Specialist Inservice Training (TRANSIT)**
DESCRIPTION: The purpose of this project is to establish regional sites that will train secondary teachers as technology specialists. The technology specialists will train classroom teachers in the use of technology to enhance the teaching and learning of mathematics. It is directed at teachers of grades 9-12 and has approximately 144 participants.
FUNDING: National Science Foundation
FACULTY: Professor Bert Waits, Department of Mathematics
Professor Frank Demana, Department of Mathematics
Professor Alan Osborne, Department of Educational Theory and Practice

PROGRAM: **Towards a Model for Implementing Science-Technology-Society Education Phase I: Status Study**
DESCRIPTION: The objective of this project (Phase I) is to conduct a nationwide survey to determine the number of states that are currently mandating STS education or its surrogates, gather comprehensive descriptions of these curricula,

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DESCRIPTION: Discovery mode; hands-on, laboratory-based course. Has no Math Pre-requisites, 2 quarter course 5-hours each quarter; currently being piloting, prepared tax material (classnotes) as well as detailed instructor manual.
FUNDING: Department of Physics
FACULTY: Professor Bunny Clark, Physics

PROGRAM: **Young Scholars Program - 1990**
DESCRIPTION: Encompasses approximately 400 7th graders in biological sciences, 400 7th and 8th graders in a math program and 200 9th graders in a unified sciences and math summer program.
FUNDING: OSU, Columbus Foundation, Howard Hughes Foundation and NSF
FACULTY: Professor James Bishop, Special Assistant to the Provost
Professor Ann Ackermann-Brown, Department of Microbiology
Professor David A. Culver, Department of Zoology
Professor Frank Demana, Department of Mathematics
Professor Barbara Thomson, Department of Educational Studies

APPENDIX B

Possible Projects within a Center for Science/Mathematics Education at The Ohio State University

I. Systemic Educational Change

1. Facilitate University wide systemic change discussions

2. Collaboration with Project Discovery on specific projects that are directed towards overall change.

II. Research and Teaching Programs in Science/Mathematics Education

1. Establish faculty positions in educational research, cognition, testing, etc. in Colleges outside Education for collaborative work

2. Assist in the development of content courses for pre-service K-12 teachers with materials, activities and approaches appropriate to the teaching of science/mathematics at the elementary, middle school and high school.

3. Conduct research into teaching efficiency; i.e., maximizing student-teacher interaction by minimizing peripheral tasks

4. Establish research programs to investigate student and faculty professional development projects.

5. Develop computer tutoring systems based on the results of ongoing learning research

6. Utilize computer graphics capabilities to study the effect of concept visualization on the learning process

7. Through conferences, seminars, etc. facilitate the acquisition of outside funds for support of research and development in science and mathematics education

III. Undergraduate Education

1. Help to coordinate an honors science/mathematics major (e.g., Northwestern Integrated Science Program) that would allow a student to go on for a science or mathematics research graduate degree while also leaving open the option for subsequent K-12 certification, perhaps as a 5 year B.S./M.S.

2. Encourage science/mathematics teaching as part of the majors course sequence; e.g., the recently approved ACS teaching option in the certified chemistry curriculum

3. Set up collaborative educational efforts for expanding formal consideration of science and mathematics in the humanities and social sciences; e.g., joint courses and appointments.

4. Establish cooperative science/mathematics teacher education programs between the basic science departments and the College of Education.

IV. Precollege Education

1. Sponsor middle school and/or high school science competitions.

2. Develop and administer an Ohio State undergraduate science placement examination and a version for high school juniors similar to the present mathematics placement examination.

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The ERIC Clearinghouse, supported by the Office of Educational Research and Improvement and its predecessors, has been a part of the science education program at the University for over 25 years. Members of the science education faculty have been instrumental in the development of the current system of collecting, organizing and distributing science education research and development products and information. This activity has resulted in over 225 monographs, an annual review of the research literature and responses to over 30,000 requests annually for information. ERIC has a major influence on both local and national research in science, mathematics and environmental education.

The Colleges of Education and of Mathematical and Physical Sciences have recently received an OERI award to establish the National Center for Science Teaching and Learning (NCSTL) at Ohio State. Currently over 60 graduate students and faculty, from around the nation as well as Ohio State, are affiliated with this Center, which promotes research on the various non-curricular factors that influence science education in K-12. Among the more than 20 projects underway are studies of university and business partnerships with school teachers, the integration of mathematics and science in teaching, science teaching with teams that involve science and agricultural teacher specialists, cultural factors that affect science learning by Japanese sojourner children, and a comparison of the effectiveness of pen-based computers, keyboard computers and pen-and-paper on science learning.

The State of Ohio has received a major grant from the NSF to establish Project Discovery, an effort at state-wide systemic change in mathematics and science education at the middle/junior high school level. Ohio State University will serve as a major site for this project. While primarily a teacher education program, this effort also entails an important research component, one that will require the appointment of additional faculty at the University.

These last three federally funded major programs, ERIC, NCSTL and Project Discovery, added to the strong base of the other funded programs reviewed above, are making The Ohio State University a national focus for science and mathematics education.

5. Leadership in Science/Mathematics Education

Excellence is a tradition in science education at The Ohio State University. Four decades ago, John Richardson and Harold Fawcett provided the leadership that established The Ohio State University as a leading American institution in science and mathematics education. The teacher education program was cited as a model by the National Science Foundation in the early 1970s. The American Association of Colleges for Teacher Education awarded the Ohio State science education program a certificate of excellence in 1972. The emphasis on excellence continues to this day as documented by the broad range of activity and by the status the program currently enjoys. This history of excellence has resulted in a strong record of leadership of state and national science and mathematics education organizations. Faculty have been presidents of the National Science Teachers Association (two), National Council of Teachers of Mathematics (two), National Association for Research in Science Teaching (three), School Science and Mathematics Association, National Physics Teachers Association, Association for the Education of Teachers of Science, National Marine Educators Association, North American Association of Environmental Educators (two) and the Science Education Council of Ohio. In addition, faculty have served on the boards of directors of the associations listed above and as chair of the education section of the American Association for the Advancement of Science. Four faculty who are members of that section are Fellows of the AAAS.

III. Possible Future Activities

In overview, The Ohio State University has made and continues to make major contributions to the support of quality science and mathematics teaching and curriculum for the schools of Ohio and the nation. E. Gordon Gee, the University President, has proposed a stronger mathematics and science education effort as one of his five priorities for the University. Previous University contributions and the individuals who have provided the inspiration for their development and implementation form the solid base for meeting that priority. To move within that priority a task force established by the University Provost has proposed a new academic program, a University Science/Mathematics Education Center, that would coordinate present and future University-wide science and mathematics education programs.

This Task Force has suggested that the mission of the proposed Center might be to: i) house and coordinate within the University research and development programs that deal with questions of science and mathematics teaching and learning; ii) contribute to the education of undergraduate and graduate students who are interested both in science/mathematics education research and in teaching; and iii) provide service to the University, Ohio citizens, and the school systems in which Ohioans learn science and mathematics.

The Task Force also suggested a number of benefits to be expected from such a Center. First, the Center would provide the leadership necessary to maintain a continuing and integrated effort throughout the University. It would serve as a magnet to help attract additional federal, state and private support. And it would be a focal point for the interaction between University and school community that is so vitally important both for research and for the implementation of new programs to improve science and mathematics education locally, state-wide and nationally.The Ohio State University is now favorably poised to wed firmly content to context, research to development. Within the present severe financial constraints, a Center would provide The Ohio State University an even stronger positive impact on science and mathematics education by gathering scientists, mathematicians, and educators under the umbrella of a Center. While it is premature to detail the programs that might be housed within a Center for Science/Mathematics Education, the Task Force did compile a general list (Appendix B) of the types of projects that could, were they implemented, draw from the strengths of this University. This list is not meant to be either inclusive or exclusive. The implementation of the Task Force's recommendations now await the approval of the University faculty and the vagaries of the current State of Ohio financial crisis.

3. Establish a unit to develop science and mathematics tests for K-12 that emphasize logical thinking, observational, problem solving, and mental synthesis skills along with alternative evaluation procedures such as performance based assessments and the use of microcomputers.

4. Expand in-service teacher education programs in cooperation with the College of Education.

5. Establish research/internship programs for teachers in K-12

V. Resource Facility

1. Establish and maintain a science and mathematics education resource center.

2. Evaluate and demonstrate educational materials; e.g., texts, computer software, packaged science projects, etc.

3. Establish a loan program for equipment and materials otherwise inaccessible to science and mathematics teachers.

4. Establish a "service personnel office" to match University faculty, staff, and students with Ohio classroom needs.

5. Establish and staff an information service such as a bulletin board service.

VI. Public Relations

1. Promote science and mathematics awareness in the public.

2. Establish a program to foster accurate and responsible representation of science and mathematics as presented through the mass media.

3. Work with governmental agencies and state legislature to promote science and mathematics education.

4. Seek active formal collaboration with COSI for community programs, such as a traveling science demonstration show.

5. Establish an office to gather information on science/mathematics education; e.g., surveys on teacher attitudes, legislative programs, parent attitudes, available resources, etc.

6. Mount an active program to influence attitudes toward science/mathematics among school principals (and related staff) and counselors.

7. Establish a program to educate local school boards on the need for and costs of strong mathematic/science programs.

8. Establish and coordinate programs for the support of science/mathematics education by civic groups such as PTO, business groups, unions, etc.

9. Work with business and industry to promote science and mathematics education.

10. Provide input into formulation of state science policies; e.g., testing, curriculum requirements, teacher certification, . . .

JUNE 21, 1992
THE PLAIN DEALER
Comics
Cleveland, Ohio
The Magazine: Cleveland's forgotten champions
Calvin and Hobbes
by WATTERSON
I'VE BEEN READING ABOUT THE BEGINNING OF THE UNIVERSE. THEY CALL IT "THE BIG BANG."
ISN'T IT WEIRD HOW SCIENTISTS CAN IMAGINE ALL THE MATTER OF THE UNIVERSE EXPLODING OUT OF A DOT SMALLER THAN THE HEAD OF A PIN, BUT THEY CAN'T COME UP WITH A MORE EVOCATIVE NAME FOR IT THAN "THE BIG BANG"?
THAT'S THE WHOLE PROBLEM WITH SCIENCE. YOU'VE GOT A BUNCH OF EMPIRICISTS TRYING TO DESCRIBE THINGS OF UNIMAGINABLE WONDER.
WHAT WOULD YOU CALL THE CREATION OF THE UNIVERSE?
"THE MORPHODYNOUS SPACE KABLOOIE!"
HMM... THAT IS BETTER.
ALMOST ANYTHING WOULD BE.
WE SHOULD LOBBY TO CHANGE THAT.
AND I THINK "TYRANNOSAUR" SHOULD BE CHANGED TO "MONSTEROUS KILLER DEATH LIZARD."

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at an early age. That's not too difficult.... kids are natural-born scientists! But with limited equipment and full curriculums, individual schools have difficulty finding the time or resources to offer real "hands-on" science experiments that keep our children interested and challenged. Together, the 10 Lake County School Districts, joined by Geauga County representatives, have created an exciting program to offer students the opportunity to get "hooked."

MATH AND SCIENCE ARE FUN-DAMENTAL

Beginning in 1991, third-graders from all Lake and Geauga schools attend the Lakeland Area Center for Science and Mathematics, located at the Auburn Career Center. The students visit the center to do hands-on, fun, and educational science experiments three times per school year.

Led by a trained educator, the hour-long lessons focus on a particular subject that is being studied in the students' regular classroom. Topics include: electricity, light and sound, the natural sciences, and weights & measurements.

There's more.... Prior to each class's first visit to the Science Center, an instructor visits the class to familiarize the students with the experiments they'll be conducting and to discuss the scientific concepts they'll be testing. The Science Center also provides hands-on instructional materials for the teacher and students to begin their experiments before their visit.

It is the policy of the Lakeland Area Center for Science and Mathematics that the educational activities, employment, programs and services are offered without regard to race, national origin, sex, religion, handicap or age.

Design and printing courtesy of: The Cleveland Electric Illuminating Company.

Printed on recycled paper.

Lakeland Area Center for Science and Mathematics

Where Today's Students Become Tomorrow's Scientists

A Project of the Lake School Superintendents Association

"BY THE YEAR 2000,

U.S. Students Will Be First In The World In Mathematics And Science"

One of the Six National Goals for Education

There is no doubt that superiority in science and math is critical to our nation's future. In Lake and Geauga counties, we're working toward this goal through a variety of educational efforts. One is the Lakeland Area Center for Science and Mathematics.

Educators agree that it's vital for our young people to get "hooked" on science and math

WOW! AWESOME!

Why Did That Happen?

What was once a welding lab has been transformed into a complete scientific laboratory, with kid-sized tables, laboratory equipment, and displays. As the students enter the Center, they pick up their lab aprons and goggles and become "junior" scientists. In small groups, they proceed to complete scientific experiments under the direction of the Center instructor, assisted by the classroom teacher and volunteer parents. Of course, there's time for some fun science play, too. (Whom the kids don't even know they're learning!) A giant guitar and a teeter-totter help demonstrate the concepts of sound and mass. And what better way to teach water displacement than by dunking the instructor in a vat of water!

The lesson doesn't end when the students leave the Center. A Center instructor visits the class after the visit to reinforce the scientific concepts they learned and show how these can be applied outside the laboratory—at home and outdoors.

Teachers are an integral part of the Center's instructional team. In cooperation with Lakeland Community College, the Center has designed workshops to help the teachers gain confidence and incorporate the Center's experiments into their classes' regular curriculum. The Center's library also has books, videos and equipment for the teachers to borrow for use in the classroom.

ADMINISTRATION & FUNDING

The Governing Board, with representatives from Lake and Geauga County schools, Lake Erie College and Lakeland Community College, provides the administrative oversight for the Center.

The Board of Directors is responsible for the day-to-day operation of the Center, including curriculum evaluation, and long-range support. The Board has representatives from local businesses, community organizations, and Lake and Geauga County schools.

The state of Ohio has provided initial funding for curriculum development, instruction and materials for the 1991-1993 school years. The Center is developing other funding sources to become self-sustaining after this two-year period. We salute these local companies who have donated materials and funding for the center: BP America, Bank One, Cleveland Electric Illuminating Company, East Ohio Gas Company, Fasson/Avery, General Electric, Lubrizol.

We need your interest and support to continue to help our children excel in mathematics and science. If you or your business can assist with funding, materials, or administrative support, contact Dr. James Porter, Lake County Superintendent, 357-2563.

VISIT US!

To learn more about the program or arrange a visit, call or write the Center. It's open every school day and is located at the Auburn Career Center, 8140 Auburn Road, near the intersection of I-90 and Route 44. The phone number is 352-8850. Please visit soon!

Students, Educators, and Community Leaders Agree...

The Lakeland Area Center For Science and Mathematics is a Winner!

"At the Science Center I had a lot of fun... When we got back we all wished we were still at the science center."—***A Lake County third-grader.***

"Students are encouraged to think for themselves, make mistakes, and try other things."—***A third-grade teacher.***

"The Center represents a significant step forward in emphasizing science education where the emphasis should be—on the elementary level. It will help our teachers provide hands-on experience for our children. The future direction of the Center is left only to our collective vision." —***Mentor Schools Superintendent Joseph Lesak.***

"In order for Ohio and our Lake County area to remain competitive economically in our rapidly changing world, it is imperative that our young people realize the importance of science and math education... We must fascinate them with science and math at an early age by capturing their interest at the elementary school level... the Lakeland Area Center for Science and Mathematics is a remarkable concept that works toward achieving this goal."—***Ohio State Representative Dan Troy.***

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TESTIMONY, COMMITTEE on GOVERNMENTAL AFFAIRS
UNITED STATES SENATE

THE LAKELAND AREA CENTER FOR SCIENCE AND MATHEMATICS

A Working Model of Systemic Change in Elementary Science and Mathematics Education

JAMES H. PORTER
LAKE SCHOOL SUPERINTENDENTS' ASSOCIATION
CLEVELAND, OHIO
July 7, 1992

Imagine a Center for Science and Mathematics that serves all elementary students; has strong inservice programs and resources for teachers; receives encouragement, support and guidance from the business and industrial community; taps the expertise of area colleges and universities and that focuses all of this on making our students **"First in the world in mathematics and science by the year 2000."**

I am Superintendent of Schools with the Lake County Board of Education, and Chairman of the Lake School Superintendents' Association which includes the Superintendents of the Local, Exempted Village, City and Vocational School Districts in Lake County along with the Presidents of Lakeland Community College and Lake Erie College. We appreciate the Committee's interest in the area of the systemic changes in science and mathematics education for all students and welcome the opportunity to share our experiences with the Lakeland Area Center for Science and Mathematics.

The Testimony will focus on 4 key points:

1. Creating a bold new approach to elementary science education was seen as imperative.

2. Why this program works.

3. Businesses, Industry, Higher Education, Parents and Government as collaborators with School Districts.

4. The Lakeland Area for Science and Mathematics as a systemic change model.

1. **Lake County School Superintendents, in collaboration with Lakeland Community College, Lake County Business & Industry, State Representative Dan Troy and the Ohio Department of Education, created this bold new approach to elementary science education as a way to make science interesting and exciting for all students.**

There is no doubt that superiority in science and math is critical to our nation's future. We all agree that it's vital for young people to get "hooked" on science and math at an early age. That's not too difficult....kids are natural born scientists! But with limited equipment and full curriculums, individual schools have difficulty finding the time or resources to offer the real "hands-on" science experiments that keep children interested and challenged. Often, their teachers who are highly skilled in reading instruction, lack the background and confidence needed to make science, and even mathematics, a great adventure for their students. Regular elementary classrooms are not set up for science either. Lack of utilities, equipment and storage makes it impossible to sustain quality hands-on programs.

Since individual schools and districts could not "go it alone" and since time in running out in the race to the year 2000 the Superintendents decided to act as a group to create the Lakeland Area Center for Science and Mathematics. What we could not accomplish separately, we can do with the collaboration of all school districts, colleges and businesses, (and are doing it!).

2. **Why this program works.**

This program is not a field trip, it is not an assembly, it is not a museum. It is a well coordinated series of hands-on, inquiry-based science experiences that involve every third grade student and teacher in all schools in Lake County and nearly all in Geauga County. (K-12 enrollment 47,000).

During the 1991-92 school year, third graders from the schools in Lake and Geauga County attended the Lakeland Area Center for Science and Mathematics located at the Auburn Career Center, our area Vocational School. The students visited the center, one classsroom at a time, to do hands-on, fun, educational science experiments three times during the year using equipment impossible to duplicate in every elementary classroom.

Topics included: **Measurement/How to be a Scientist; Light and Sound; Electricity and Magnetism.** **There's more**...Prior to the visit to the Center, an instructor visited each class in their own classroom to familiarize them with the experiments they would be doing and the concepts they would be testing. Hands-on materials were left with the classroom teacher so students would be really ready for their visit. **And there's more.....** Classroom teachers are a part of the instructional team too! In cooperation with Lakeland Community College, the Center Staff designed workshops to help teachers gain confidence and incorporate the Center's experiments into their class's regular curriculum. These workshops, held on after-school time, preceded each new topic and provided teachers additional ideas and materials to take back to their classrooms.

The program works because of these features and it works because every School Board has passed a resolution making it a required part of the districts' educational experience for every student. (See resolution sample in Appendix) It works because every student has six (6) high quality, exciting science experiences each year. Their teachers get three (3) great inservice programs and lots of "stuff" to use in their own classrooms.

The Lake School Superintendents are convinced that this level of structure and support is required to make systemic change happen in elementary science education.

3. **Businesses, industry, parents, colleges, government and schools have collaborated in the programs design and operation.**

You cannot buy a Center for Science and Mathematics....not yet. To make this program a reality for Lake and Geauga County children, a large number of dedicated people committed their talents, energies and resources. The Governing Board of the Center includes all the School Superintendents in the County (11) and the Presidents of Lakeland Community College and Lake Erie College. (See membership listing in Appendix) Working directly with this group is the Board of Directors whose members are teachers, business executives, scientists, school administrators, industry representatives, private foundation representatives and government agency representatives. (See membership listing in Appendix) The Board of Directors is responsible for organizing the instructional program and providing advice and support from business and industry. Sub-groups of the Board work directly with the Science Center Staff in planning and preparing the experiences students have at the Center. Specialized equipment is designed and built when it cannot be purchased.

The Directors developed the Center's Mission Statement and Program Goals:

Lakeland Area Center for Science and Mathematics

Mission Statement

The mission of the Lakeland Area Center for Science and Mathematics is to make working with science and mathematics exciting and interesting for all young people so that they will develop a life-long curiosity about the world around them.
The center will....
- enhance, enrich and extend the Science and Mathematics instruction in our schools by providing hands-on science and math activities for the students who visit.
- provide inservice training for area teachers and serve as a science and math resource center providing teachers with supplemental materials and ideas for teaching science and math in their classrooms.
- demonstrate how science and mathematics are used in the business community through close cooperation with area businesses and industries.

Program Goals

The goals of the Lakeland Area Center for Science and Mathematics are to.....

- build on children's natural curiosity and help them learn to investigate the world around them by using scientific processes.
- provide all students with hands-on science activities designed to stimulate student interest in science and mathematics early in life.
- encourage families to take an interest in science and mathematics education.
- involve local businesses in science education and utilize the resources businesses can provide.
- foster the development of creative thinking in conjunction with student inquiry and process skills required for problem solving in all areas of living.
- provide opportunities for teachers to enhance and enrich their knowledge of science and mathematics concepts and to develop creative teaching strategies.

With these clear targets and the full cooperation of everyone it's no wonder that our first year of operation was an unqualified success. 20,000+ student contacts (all third graders, 6 times!) and nine inservice sessions attended by third grade teachers, (on their own time!), resulted in strong positive evidence of the beginnings of exciting systemic change in elementary science education across both counties. In 1992-93 the program will double its impact by including both 3rd and 4th grades, and ultimately add 5th grade as well.

4. The Lakeland Area Center for Science and Mathematics is a high-potential model for systemic change in elementary science education because:

- Schools have made the Center program a required part of their science education program on a regular schedule (See Appendix).
- ALL children participate.
- Teachers are provided high quality, regular, inservice by college staff members and given materials to use in their classrooms.
- Center lessons are well planned, exciting, hands-on, inquiry-based experiences for the students using specially designed equipment.
- Contributions by minorities and women to science programs are routinely highlighted in Center presentations.
- Business and Industry representatives and practicing scientists are involved in lesson planning and development and in securing equipment and materials.
- Program evaluation is designed in cooperation with University faculty.
- Facilities are provided, at no cost, by the Vocational Board of Education, requiring no additional construction.
- Applied mathematics is incorporated into each inquiry based science lesson using Ohio's Model Math Curriculum.
- Vocational/Technical students assist the Center by creating much of the needed equipment.
- The Center staff has both females and males, giving all students good role models stressing that service vocations are for everyone.

- Real-life experiences with science provide an excellent alternative to high tech and textbook based instructional programs.
- Parents come with classes as helpers and get "hooked" on science and on the Center program.
- Business, Industry and Community leaders have attended a Grand Opening Celebration and continue their support (See Appendix).
- Students work as scientific teams - using Cooperative Learning strategy.
- The inertia of - we always do it that way - has been overcome and we have enthusiastic participation by teachers in their classrooms and at inservice sessions.
- We have fought successfully through the problem of moving from theory to practice in lesson design.
- Professional scientists are involved in all phases of the program.
- The Lakeland Area Center for Science and Mathematics group has an overall plan for the future of the Center. (See diagram in Appendix)

Twenty-five years ago the State of Ohio determined that Vocational Education was critical to our nation's future. We built a network of vocational/technical schools and provided programs to all students. Other states made similar efforts. Today, we know that we face serious challenges in preparing our students and citizens in the areas of math and science. The Lakeland Area Center for Science and Mathematics, located in the Auburn Career Center Vocational School, takes advantage of excellent existing facilities, vocational/technical student assistance, and already established school district cooperation to bring high quality, inquiry-based, science experiences to all students.

Requiring only modest investment in personnel and equipment, a state-wide or even national system of science centers such as this one could be set up quickly and have immediate impact on science and mathematics education.

The year 2000 approaches quickly. The Lake and Geauga County 3rd graders in the Center program this year will enter the 12th grade in the year 2000! That is why School District, Business, Industry and Governmental leaders have made the Lakeland Area Center for Science and Mathematics a reality today, and that is why we urge you to consider it as a model that can be duplicated for all children.

LAKELAND AREA CENTER FOR SCIENCE AND MATHEMATICS
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Dr. James Porter, Chairman
County Board of Education

LAKELAND AREA CENTER FOR SCIENCE and MATHEMATICS

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LAKE SCHOOL SUPERINTENDENTS' ASSOCIATION
LAKELAND AREA CENTER FOR SCIENCE AND MATHEMATICS

RESOLUTION OF PARTICIPATION

WHEREAS: There is no doubt, given recent events, that superiority in science and mathematics is critical to our nation's future, and;

WHEREAS: A Center for Science and Mathematics that serves all elementary students in Lake County; has strong in-service programs and resources for teachers; provides students/families facilities and guidance for individual research and experimentation; and features displays and exhibits that promote the scientific activities of Lake County Businesses and Industry will be a tremendous asset to out school children and the whole Lake County Area, and;

WHEREAS: As a pilot project, the Lake School Superintendents' Association in cooperation with the Auburn Career Center, Lakeland Community College and the Lake County Board of Education plan to provide high quality, high motivation, hands-on science lessons on a regular basis for one grade level and accompanying teacher in-service in a Center for Science and Mathematics format for the 1991-92 school year, and;

WHEREAS: As this is shown to be effective the other components can be developed in cooperation with Lake County Businesses and Industry and area Foundations;

THEREFORE BE IT RESOLVED: The Wickliffe City School District will participate in the pilot Center for Science and Mathematics program during the 1991-92 school year with students in the third grade experiencing a minimum of 4 lessons at the Center and staff members receiving the in-service training offered in conjunction with the program. It is understood that the program will be housed at the Auburn Career Center and in-service programs will be scheduled at Lakeland Community College or at the Auburn Career Center as appropriate. It is also understood that Wickliffe City School District shall be responsible for student transportation to the program and a fee of not more than $5.00 per student per lesson.

Karen A. Sciarra 5/15/91
President Date

David F. Tanski 5/15/91
Superintendent Date

MADISON LOCAL SCHOOL DISTRICT
6741 North Ridge Road Madison, Ohio 44057 Telephone (216) 428-3166 Fax (216) 948-8472

May 17, 1991

Dr. James Porter, Superintendent
Lake County Board of Education
P. O. Box 490
Painesville, Ohio 44077

Dear Dr. Porter:

I am writing this letter to notify you that the Madison Board of Education adopted the following resolution at its regular meeting on May 16, 1991.

> WHEREAS there is no doubt, given recent events, that superiority in science and mathematics is critical to our nation's future, and;
>
> WHEREAS a Center for Science and Mathematics that serves all elementary students in Lake County; has strong in-service programs and resources for teachers; provides students/families facilities and guidance for individual research and experimentation; and features displays and exhibits that promote the scientific activities of Lake County Businesses and Industry will be a tremendous asset to our school children and the whole Lake County Area, and;
>
> WHEREAS as a pilot project, the Lake County School Superintendents' Association in cooperation with the Auburn Career Center, Lakeland Community College and the Lake County Board of Education plan to provide high quality, high motivation, hands-on science lessons on a regular basis for one grade level and accompanying teacher in-service in a Center for Science and Mathematics format for the 1991-92 school year; and;
>
> WHEREAS as this is shown to be effective the other components can be developed in cooperation with Lake County Businesses and Industry and Area Foundations;
>
> THEREFORE BE IT RESOLVED the Madison Local School District will participate in the pilot Center for Science and Mathematics program during the 1991-92 school year with students in the third grade experiencing a minimum of 4 lessons at the Center and staff members receiving the in-service training offered in conjunction with the program. It is understood that the program will be housed at the Auburn Career Center and in-service programs will be scheduled at Lakeland Community College or at the Auburn Career Center as appropriate. It is also understood that the Madison Local School District shall be responsible for student transportation to the program.

I look forward to working with you to make the Center a success. Make it a GREAT DAY!

Sincerely,

Stan W. Heffner
Superintendent

SWH:js

Fairport Harbor Public Schools
Fairport Harbor, Ohio 44077

Harding High School
329 Vine Street
(216) 354-3592

Office of Superintendent
329 Vine Street
(216) 354-5400

Dr. Michael D. Whitacre
Superintendent

McKinley Elementary
602 Plum Street
(216) 354-4982

LAKE SCHOOL SUPERINTENDENT'S ASSOCIATION
LAKELAND AREA CENTER FOR SCIENCE AND MATHEMATICS

RESOLUTION OF PARTICIPATION

WHEREAS: There is no doubt, given recent events, that superiority in science and mathematics is critical to our nation's future, and;

WHEREAS: A Center for Science and Mathematics that serves all elementary students in Lake County; has strong in-service programs and resources for teachers; provides students/families facilities and guidance for individual research and experimentation; and features displays and exhibits that promote the scientific activities of Lake County Businesses and Industry will be a tremendous asset to our school children and the whole Lake County area, and;

WHEREAS: As a pilot project, the Lake School Superintendents' Association in cooperation with the Auburn Career Center, Lakeland Community College and the Lake County Board of Education plan to provide high quality, high motivation hands-on science lessons on a regular basis for one grade level and accompanying teacher in-service in a Center for Science and Mathematics format for the 1991-92 school year, and;

WHEREAS: As this is shown to be effective, the other components can be developed in cooperation with Lake County Businesses and Industry and area Foundations;

THEREFORE BE IT RESOLVED: The Fairport Harbor Exempted Village School District will participate in the pilot Center for Science and Mathematics program during the 1991-92 school year with students in the third grade experiencing a minimum of four (4) lessons at the Center and staff members receiving the in-service training offered in conjunction with the program. It is understood that the program will be housed at the Auburn Career Center and in-service programs will be scheduled at Lakeland Community College or at the Auburn Career Center as appropriate. It is also understood that the Fairport Harbor Exempted Village School District shall be responsible for student transportation to the program and a fee of not more than $5.00 per student per lesson.

Board President — 5-31-91 Date — Superintendent — 5/29/91 Date

LAKE SCHOOL SUPERINTENDENTS' ASSOCIATION
LAKELAND AREA CENTER FOR SCIENCE AND MATHEMATICS

RESOLUTION OF PARTICIPATION

WHEREAS: There is no doubt, given recent events, that superiority in science and mathematics is critical to our nation's future, and;

WHEREAS: A Center for Science and Mathematics that serves all elementary students in Lake County; has strong in-service programs and resources for teachers; provides students/families facilities and guidance for individual research and experimentation; and features displays and exhibits that promote the scientific activities of Lake County Businesses and Industry will be a tremendous asset to our school children and the whole Lake County Area, and;

WHEREAS: As a pilot project, the Lake School Superintendents' Association in cooperation with Lakeland Community College and the Lake County Board of Education plan to provide high quality, high motivation, hands-on science lessons on a regular basis for one grade level and accompanying teacher in-service in a Center for Science and Mathematics format for the 1991-92 school year, and;

WHEREAS: As this is shown to be effective the other components can be developed in cooperation with Lake County Businesses and Industry and area Foundations;

THEREFORE BE IT RESOLVED: The Auburn Vocational School District will cooperate in the pilot Center for Science and Mathematics program during 1991-92 school year by housing the program at the Auburn Career Center and providing housing related services.

President 5-7-91 Date Superintendent May 7, 1991 Date

Lakeland Area Science Center

Project Proposal

PROJECT GOAL: The establishment of a local area Science Center to enhance, enrich and extend the Science and Math instruction in our schools by providing Hands-on Science Activities for visiting students and teachers from schools throughout Lake County.

FOCUS: A regular schedule of elementary class visitations for all public schools in the Lake County Area.

FOCUS: A Teacher Training Center providing workshops in Science, Math and Technology for teachers from throughout Lake County.

FOCUS: A Science Resource Materials Center and Library accessible to all classroom teachers throughout Lake County.

FOCUS: A Project Laboratory for "long term" investigations and projects by students (and teachers) from throughout Lake County.

PROPOSED:

A facility with at least four classroom/ laboratory areas, a lobby/display area, a "long-term" project area, and a resource-materials storage and library area.

A staff to include a full-time director/ instructor, a full-time secretary, and several part/full-time teachers.

Equipment, programs and materials which, although needed for providing quality science education in the decade of the 1990's and beyond, would be "cost prohibitive" for individual school districts.

Sample School Schedule

Lakeland Area Center for Science and Mathematics - Grade 3 - Visit #1

Date	Visitation Time*	District	School	Teacher
9/16/91	9:00 - 10:00	Mentor	Bellflower	McCalla
	10:30 - 11:30	Mentor	Bellflower	Berac
	12:00 - 1:00	Mentor	Bellflower	Carapak
9/17/91	9:00 - 10:00	Mentor	Bellflower	Trusso
	11:00 - 12:00	Mentor	Brentmoor	Spinello
	1:15 - 2:15	Mentor	Brentmoor	Minadeo
9/18/91	9:00 - 10:00	Mentor	Garfield	Bennet
	10:30 - 11:30	Mentor	Garfield	Bellomo
	12:00 - 1:00	Mentor	Garfield	Simmons
9/19/91	9:30 - 10:30	Mentor	Headlands	Tannenbaum
	11:00 - 12:00	Mentor	Headlands	Bloch
	1:15 - 2:15	Mentor	Headlands	Howard 2-3 split
9/23/91	9:30 - 10:30	Mentor	Hopkins	Pular
	11:00 - 12:00	Mentor	Hopkins	Chappel
	1:15 - 2:15	Mentor	Center Street	Lennon
9/24/91	9:30 - 10:30	Mentor	Hopkins	Parker
	11:00 - 12:00	Mentor	Hopkins	May 2-3 split
	1:15 - 2:15	Mentor	Center Street	Richards
9/25/91	9:30 - 10:30	Mentor	Fairfax	Wyar
	11:00 - 12:00	Mentor	Fairfax	Plescia
	1:15 - 2:15	Mentor	Fairfax	Pedaji
9/26/91	9:30 - 10:30	Mentor	Lake	Bertheld
	11:00 - 12:00	Mentor	Lake	Kehres
	1:00 - 2:00	Mentor	Lake	Yoder
9/30/91	9:00 - 10:00	Fairport	McKinley	Hearn
	10:30 - 11:30	Mentor	Morton	Muehlhauser
	1:00 - 2:00	Mentor	Morton	Garris
10/1/91	9:30 - 10:30	Mentor	Orchard Hollow	Bereas
	11:00 - 12:00	Mentor	Orchard Hollow	Carney
	1:15 - 2:15	Mentor	Orchard Hollow	Sankai
10/2/91	9:00 - 10:00	Mentor	Reynolds	King
	10:30 - 11:30	Mentor	Reynolds	Moorhead
	12:00 - 1:00	Mentor	Reynolds	Vetrano
10/3/91	9:40 - 10:40	Mentor	Rice	Fletcher
	11:10 - 12:10	Mentor	Rice	Fogarty
	1:30 - 2:30	Mentor	Rice	Singh

* Transportation will be provided by Perry Schools. Expect the bus to arrive at your building approximately 20-30 minutes before each scheduled visitation.

BEST COPY AVAILABLE

Statement before the
Committee on Government Affairs
United States Senate

Field Hearing on Mathematics and Science Education Reform
Cleveland, Ohio
July 7, 1992

Honorable Chairman Glenn and committee members. My name is Michael Salkind. I am President of the Ohio Aerospace Institute which is a private, non-profit consortium of 9 Universities, 2 Federal laboratories, and several dozen companies. Our mission is to facilitate collaboration among these three sectors in graduate and continuing education, research, and technology transfer.

Although our mission focuses primarily on graduate engineering education and research, through the Ohio Space Grant Consortium, we also have a major effort in encouraging more Americans, from kindergartners through college students, to pursue science and math education, with special emphasis on encouraging more women and minorities. In this, we support the President's AMERICA 2000 education strategy.

The collaborative efforts of OAI are built around the two outstanding Federal Aerospace Laboratories in Ohio - NASA Lewis Research Center in Cleveland and Wright Patterson Air Force Base in Dayton. Both facilities act as magnets to attract visiting faculty,

students, and industry collaborators to work with each other, have access to world class experimental and computational facilities, and work on cutting edge, real world programs. In this way, graduate students experience an enriched education, by being exposed to industry and government perspectives.

Collaborative activities in OAI are conducted within Focus Groups. These are networks of colleagues from the three sectors who develop a common strategy in both research and education. They conduct research, develop courses, and conduct conferences, seminars, and workshops to advance the state of knowledge in their areas of expertise. There are 13 such focus groups in diverse technology areas such as advanced materials, propulsion, power, computer simulation, dynamic systems and control, visualization, and aircraft icing. Through direct industry participation, these Focus Groups bring a market perspective to the research agenda. In this way, technology can more expeditiously be used to impact economic development.

To encourage more Americans to pursue degrees in engineering and science, the Ohio Space Grant Consortium, managed by OAI, has awarded more than $1.8 million in the past 3 years to 52 graduate and 78 undergraduate students. The funding has been provided by the NASA Space

Grant College and Fellowship Program and NASA Lewis Research Center with matching funds from the State of Ohio and Industry.

With me today is Renee Kent who is the recipient of a NASA Space Grant/OAI fellowship. She is a Doctoral student in the Materials Engineering Department at the University of Dayton, one of the OAI member universities. She expects to receive her PhD in August, 1992 and has been in residence at OAI for the past two years. She has been conducting her thesis research in the Structures Division of the NASA Lewis Research Center. The focus of her research has been the development and implementation of a new method for determining mechanical properties of new fiber materials. These new high strength materials are being developed for high performance, high temperature structural applications in programs such as the National AeroSpace Plane (NASP) and future high performance turbine engines. Her experience here has also brought her in contact with industry collaborators and considerably broadened her educational experience. Renee Kent observed that her educational experience was characterized by many teachers and mentors who found great excitement in their own scientific endeavors as well as in the development of young people. She felt that when learning and discovery were introduced in an exciting and interesting way, she and

her fellow students learned successfully.

If we are to attract more young Americans, such as Renee Kent, to pursue technical careers and graduate education, we must ensure that more young people are motivated to study mathematics and sciences in the primary and secondary grades. To this end, we established the Ohio Space Grant Consortium Education Pipeline Committee which includes members from primary and secondary education, Universities, Federal laboratories, and industry. They conduct programs for teachers and students in kindergarten through graduate school with special emphasis on female and minority students. Attached is a summary of some of the outreach programs. Because OAI is a network of engineering and science practitioners, it serves as a reservoir of volunteers to work with teachers and students. The Ohio Space Grant Consortium is planning to develop this network of volunteers and link them with local school systems.

One of these activities has been a series of workshops for elementary school teachers to introduce the World In Motion (WIM) program developed by the Society of Automotive Engineers (SAE). This program, developed by a national team of educators and practicing engineers, uses mobility technology (e.g., small cars and boats) for learning basic principles of physical sciences and mathematics. In

addition to the teacher workshops, practicing engineers and engineering graduate students are made available to assist teachers in and out of their classroom.

With me today is Mrs. Sue Zepp, a third grade teacher in the Woodridge Elementary School in Akron. Mrs. Zepp has used the World In Motion Program in her class with exciting results. She used it in a reading module, rather than a math or science module, and found it could fit into anything. She felt it was the kind of hands-on, cross-disciplinary, cooperative educational experience that is being encouraged by education experts and emphasized in the American Association for the Advancement of Science's Project 2061. She was excited because while traditional abstract math modules have little meaning for her students, they learned advanced mathematics skills and used their calculators in order to determine averages and trends in their World In Motion experiments. In letters from this year's third graders to next year's third graders, her students mentioned the World In Motion experience with great enthusiasm. Another program we conducted involved bringing 150 Girl Scouts to the Cleveland Children's Museum on three successive weekends for programs using the museum's hands-on Water, Bridges, and Time exhibits. The program was conducted in conjunction with the Society for Women

Engineers and adult women practicing engineers served as role models for the 6 to 10 year old girls. We need more such programs to counter the societal stereotypes that discourage women and minorities from pursuing mathematics and science.

From our experience, I would recommend that the Federal Government consider the following in the goal to improve the education of American students in mathematics and science. We have a cadre of practicing scientist and engineers in industry, universities, and Federal laboratories who are competent and comfortable in math and science. If we can harness that talent pool to assist teachers and students in our primary and secondary schools, we can make significant improvements.

American professional technical societies, through programs such as World In Motion and MathCounts, are helping bring this army of volunteers to focus on our schools, but they need help. They need funding to provide the staff efforts to support such programs and the data base management to couple a dispersed army of volunteers with local schools.

Such services must be organized on a local or regional basis because our school systems are local. We need to help stimulate the creation of such a local or regional infrastructure. The National Science Foundation's Statewide Systemic Initiative, which in Ohio is called Project Discovery,

has the potential to help create such an infrastructure. We need to build new regional resource centers. And we must find ways of integrating the many existing support programs into these regional resource centers so that our schools can connect to these resources more readily.

There are currently many diverse programs for coupling volunteers with local schools. NASA Lewis Research Center in Cleveland has a wonderful educational resource center for teachers. They also have many employees participating in volunteer programs with local schools such as their program with East Technical High School and the local Physics Alliance. Wright-Patterson Air Force Base in Dayton has similar programs for coupling employees with local public schools. Our universities also have many programs to couple faculty and student volunteers to local schools. Private companies participate in a broad range of efforts including adopt-a-school programs. Several years ago, a local agency cataloged such programs in northeast Ohio and the result was a rather thick book. Both the schools and would-be volunteers are overwhelmed by the number of such efforts, which makes it more difficult to channel specific capabilities to specific needs. We need well staffed regional resource centers to maintain current data bases of such capabilities and expeditiously bring capabilities together with needs. This is no small

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challenge and current programs are not adequate to address these needs.

The Federal Government can also help by supporting consortia to help bring together resources for collaboration. We need to promote collaboration in both education and research. The NASA Space Grant College and Fellowship Program, with consortia in all 50 states, the District of Columbia, and Puerto Rico, is a major national program with specific mission responsibility for kindergarten through graduate school education in engineering, math and science. It is an excellent vehicle for affecting change.

I would recommend that the Federal Government investment could be most effective if focused as matching funds for consortia demonstrating the ability to attract private sector (and state or municipal) funding. I would also strongly recommend tax incentives for industry investment in education and research, and especially for collaborative activities through consortia. These programs could be especially effective if they provide incentives for coupling private sector efforts with Federal laboratories through consortia.

In summary, I would recommend that we:

- Strengthen the coupling of industry, Federal laboratories, and university engineers and scientists to our educational enterprise through targeted programs, consortia, and tax incentives.
- Support innovative educational programs, such as SAE's World In Motion, that provide exciting, engaging, hands-on modules to school teachers and volunteers to help teachers implement them.
- Develop regional resource centers to maintain innovative mathematics and science programs and a staff to help schools select and implement such programs.

Thank you for inviting us to participate. My colleagues and I would be happy to answer any questions.

NASA

OHIO SPACE GRANT CONSORTIUM

Ohio Space Grant Consortium Pipeline Programs:

- **Bridges, Water and Time (4/27/91; 5/4/91; 5/11/91)**
  This program was Co-Sponsored by the Society of Women Engineers, the Cleveland Children's Museum and the Ohio Space Grant Consortium for the Lake Erie Girl Scouts. 150 girls in grades 1-5 attended as well as 20 Mentors and Administrators. The primary objective for the program was to increase awareness/ provide motivation for science, math, and technology.

- **Highland High School Career Day (1/14/91)**
  This program was a career day. Diane M. Swec of NASA Lewis Research Center represented the Ohio Space Grant Consortium. The panel consisted of five women, representing the following professions: chemical engineer, electrical engineer, nursing supervisor, veterinarian and architect. The panelists discussed the rewards, obstacles and opportunities in the scientific fields. They fielded questions from students, and discussed their careers, education and experience. 21 girls grades 9-12 attended and 3 teachers

- **Physics Alliance (2/5/92)**
  Sheila Bailey of NASA Lewis Research Center represents the Ohio Space Grant Consortium and NASA at the meetings of the Physics Alliance. An Academic Alliance is a model of professional collaboration developed by Claire Gaudiani, who is now president of Connecticut College. The American Association for High Education's National Project in Support of Academic Alliances aims to institutionalize the Academic Alliances concept so that participation is an integral part of the Professional Life of School and college faculty. The local Physics Alliance provides excellent networking opportunities among teachers (high school and college) and professional physicists and mathematicians. (Current attendance: 15 persons)

- **Space Simulation at University Schools (1/21/92)**
  Twenty-one students (grades 4-8) from Berea City Schools took a one-day field trip to the University School in Shaker Heights, Ohio. All of the students had an opportunity to fly s simulated shuttle orbital mission. The students performed real tasks in the shuttle

OAI Ohio Aerospace Institute
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simulated, used the controls on the flight deck and working in a position at mission control. This program was coordinated by Lois Kostenbader of the Talented and Gifted Program (TAG) in Berea City Schools.

- **The LEGO Dacta Workshop** (11/1/91)
  This workshop was presented for 17 teachers and program administrators of K-12 science and math programs so that they could become aware of the many valuable aspects of the LEGO materials for instruction. By building the LEGO models, students develop their construction, numeric, graphing and problem solving skills. With the LEGO TC logo system, students can use the computer to program various models to effect change or movement.

- **WINGES-Upward Bound** (10/11/91-10/12/91)
  WINGES (Women in Graduate Engineering Studies) was formed in 1990 at the University of Dayton to provide a support network for women in graduate engineering studies. WINGES recruits women engineers to pursue advanced degrees and focuses on retaining them while they are in graduate school. The goals of WINGES is to increase the number of women engineers entering graduate school. The purpose of the October 11-12, 1991 seminar was to help women explore graduate engineering opportunities in Ohio. At the seminar, women learned how to "get started" in a graduate program and discovered ways to locate funding such as fellowships and assistantships. 68 women attended.

- **World in Motion--Canton City Schools** (12/14/91; 5/21/92)
  A World in Motion (WIM), a unique program sponsored by the Society of Automotive Engineers (SAE), brings engineers into the classroom to serve as teaching assistants, role models, and mentors. In our program, engineers, as well as, engineering students from the University of Akron served as teaching assistants. WIM is part of SAE's Vision 2000, a program designed to assure a skilled engineering and technical workforce for the year 2000 and beyond. Specifically designed for grades 4-6, a WIM utilizes mobility technology as an impetus for learning basic physical science principles. The program was developed by a national team of educators and practicing engineers. OSGC has run a series of workshops for teachers in the Canton School System. The goal of

this program is to effect change and expand/enhance teaching methods for science, math and technology subjects. 20 teachers have been involved in this process.

- **Launch-O-Rocket Program--Streetsboro City Schools** (5/27/92) On Wednesday, May 27, 1992 from 4:00-5:30 p.m. students from Streetsboro Middle School presented a Rocket Launch Demonstration at the School.

  Over the past six weeks, sixty-one (61) 4th, 5th, 6th and 7th grade students have been studying the principles of rocket science and learning how to build a rocket. The program co-sponsored by the Ohio Space Grant Consortium and the Jennings Foundation was directed by Mr. Edward Arida, Teacher of the Gifted and Talented in the Streetsboro School System.

  By way of theory and through direct application, students learned about Newton's laws of motion; chemical reactions involved in solid propellant engines; electricity as applied to engine ignitions; basic principles of aerodynamics; use of trigonometry in tracking and altitude determination; and safety precautions for the building and launching of their rockets. Each student built a rocket, and worked as member of a team to launch, track and recover their rockets.

  Students invited their parents, school principles and administrators, and representatives from the Ohio Space Grant Consortium to attend the event.

OAI Room 1K, Ohio Aerospace Institute
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Empowering Young Women to Achieve in Science, Engineering and Research

Testimony of

Elizabeth Obara

Director

The B-WISER Camp
of
The Ohio Academy of Science

Presented to

The United States Senate
Committee
on
Governmental Affairs

The Honorable John Glenn
Chairman

Tuesday, July 7, 1992
NASA Lewis Research Center
Cleveland, Ohio

The Ohio Academy of Science
1500 West Third Avenue Suite 223
Columbus OH 43212-2817
Phone or FAX (614) 488-2228

Mr. Chairman, members of the committee, friends and colleagues. My name is Elizabeth Obara. Since 1987 I have been a science teacher at Dublin High School, Dublin, Ohio. Prior to that I taught for 22 years in Indiana, Germany and Ohio. As a classroom teacher -- on the front line of education -- I am particularly pleased to accept your invitation to appear before you today to discuss the B-WISER Institute, a summer science camp and follow-on program which empowers young women to achieve in science.

The mission of The Ohio Academy of Science, a non-profit organization of those interested in science and technology, is to empower curiosity, discovery and innovation by stimulating interest in the sciences and technology, promoting and supporting research, improving science education, disseminating scientific knowledge, and recognizing and publicizing high achievement in attaining these objectives. Through its Junior Academy, Senior Academy and Central Office, The Ohio Academy of Science provides support activities, runs annual meetings and science fairs, and publishes a journal and newsletter that report developments in science, engineering, technology and education.

In a special report entitled "Minorities in Science" in the April 15, 1991 issue of *Chemical & Engineering News*, Joseph G. Danek of the National Science Foundation wrote, "We have created artificial situations in which there are no alternative pathways to successful careers except for children to do well in a very short window that begins at the seventh grade. To keep up, science will have to attract more minorities and female students."

The B-WISER Institute is a creative and effective response to these issues.

What is The B-WISER Institute? -- The Buckeye Women in Science, Engineering and Research Institute?

The B-WISER Institute, is an educational partnership of The Ohio Academy of Science, WISEMCO - The Women in Science, Engineering and Mathematics Consortium of Ohio and The College of Wooster. This year long program consists of the B-WISER summer science camp at The College of Wooster for 7th grade female students and a follow-on research internship for students under the supervision of professional women in science in colleges and universities, government and industry. This program is supported in part by a grant to The College of Wooster from The Ohio Board of Regents from funds available under the Eisenhower Science and Mathematics Education Act.

The purpose of the B-WISER Institute is to enhance the interest of 100 seventh grade girls in physics, chemistry, biology, geological sciences, computer science and math. The institute consists of three activities: (1) a summer B-WISER camp at The College of Wooster, (2) a year long internship for each of the 100 research interns with the EXEMPLARS who are women in science identified by The Ohio Academy of Science, and (3) a career workshop for the 100 research interns, their parents and their supervising EXEMPLARS.

This program builds on efforts of an existing partnership between The College of Wooster and The Ohio Academy of Science for B-WISER, the Buckeye Women in Science, Engineering and Research Camp held on June 9-14, 1991. The camp is a team taught, hands-on, residential experience using the well equipped classrooms and facilities of The College of Wooster. Most of the 18 faculty members at the camp are pre-college teachers well known in Ohio for their ability to affect student attitudes and learning in science and mathematics. Moreover, the B-WISER Institute taps the talents of nearly 100 of the over 250 EXEMPLARS who are volunteer women in science, engineering and mathematics for The Ohio Academy of Science.

The research interns -- young women entering 8th grade in the Fall of 1992 (seventh graders during the school year 1991-1992) -- will be approximately 21-22 years old and ready to enter the workforce or graduate school by the year 2000. Therefore, it is very important

that we begin training our young women now for full participation in mathematics and science to avert the predicted future shortage of talent.

The goals of the B-WISER Institute are:

1. To develop student content knowledge in specific sciences and math.

2. To develop student skills in the process of scientific investigation and research methods including selecting a research topic, developing testable hypotheses, devising tests and collecting data, and drawing conclusions.

3. To enhance student awareness of career possibilities and requisite qualifications for careers in the scientific disciplines.

4. To generate enthusiasm for science and a sense of participation in scientific discovery.

5. To facilitate student assessment of potential skills and abilities for science careers.

6. To place 100 young women research interns, with professional women EXEMPLARS, so that the research intern may work on a science project with the role model/mentor throughout the 1992-1993 school year.

7. To enable the research intern to present her project for judging at local, district and state science days at the end of the year-long scientific experiences with the EXEMPLAR.

8. To hold a one day career conference in the Fall of 1992 with research interns, counselors, financial aid experts and college admission officers from Ohio colleges and universities.

9. To prepare three *Early Alert Tip Sheets To Careers in Science, Engineering, and Mathematics* on the topic of admissions testing, scholarships available, and youth science opportunities such as The American Junior Academy of Science, the Westinghouse Science Talent Search and the International Science & Engineering Fair.

Anticipated Outcomes

As a result of participating in this year-long Buckeye Women In Science Engineering and Research Institute, the research interns will do the following.

1. Include additional science and mathematics in their choices for high school classes.

2. Continue doing scientific research during high school, either with the EXEMPLAR role model, or with another scientist.

3. Present her science project for judging at local, district, and state science days.

4. Be able to know where to apply for research funds, and then receive them.

5. Be more knowledgeable about scientific careers and the ways in which to access them.

6. Be very aware of the many opportunities in The Ohio Junior Academy of Science; The Junior Science and Humanities Symposium; The Ohio Academy of Science Annual Meeting; and The International Science and Engineering Fair.

7. Plan for a career in science, engineering or mathematics when she enters college.

The B-WISER Institute will build on an existing partnership and extend the camping experience into a year-long research internship through the engagement of EXEMPLARS of The Ohio Academy of Science. The 250 currently active EXEMPLARS represent more than 140 cooperating employers including such well known companies as Adria Laboratories, American Electric Power Service Corporation, Ashland Chemical, BFGoodrich Company, Battelle Memorial Institute, BP America, Chemical Abstracts Service, Columbia Gas of Ohio, Dow Chemical USA, DuBois Chemicals Inc., EI Dupont de Nemours & Co. Inc., Ferro Corporation, NASA Lewis Research Center, Ohio Power Company, Procter & Gamble, Ross Laboratories, Scott Fetzer Company, SofTech Inc., The General Electric Company, The Kroger Company, The Timken Company, Toledo Edison, United Telephone Company of Ohio, Westinghouse Materials Company, and Whirlpool Corporation.

At the 1992 B-WISER Camp at The College of Wooster, there were 100 students from more than 72 schools in 36 of Ohio's 88 counties. Urban, rural, public and non-public schools were well represented as shown on the attached list of participants.

The staff for the B-WISER Institute consists of Dr. Ted Williams, Project Director for The College of Wooster; Mr. Lynn E. Elfner, Assistant Project Director for The Ohio Academy of Science; Elizabeth Obara, B-WISER Camp Director; Dr. Lois A. Cook, B-WISER Camp Assistant Director; and Dr. Nadine K. Hinton, Evaluation Consultant.

Mr. Chairman, although my remarks today have focused specifically on the B-WISER Institute, I respectfully request on behalf of The Ohio Academy of Science that you leave the record of this hearing open until July 10, 1992 to enable the Academy to submit additional written testimony relative to the questions concerning systemic change in education.

Although more detail will be submitted in the additional written testimony, I do want to point out, now, a specific change in Federal law which could facilitate the creation of many more programs like The B-WISER Institute. One of the problems with the legislation which authorizes the Eisenhower program is the bias against not-for-profit organizations like science academies, science centers and museums and other community based organizations. At this time the Academy cannot receive funds directly from the Eisenhower program; we are forced to use academic institutions as fronts for proposals. This is a disincentive to creativity and innovation in program design and administration. It impedes the proposal development process, puts up barriers to inter-institutional cooperation and imposes additional administrative costs on an already overburdened system. The Academy feels that the competition for Federal grants should be wide open – the best ideas and programs should be funded without a built in administrative filter.

In conclusion, The Academy feels that the B-WISER Institute empowers young women to achieve in science. In his book entitled *The Best of Success*, Wynn Davis writes, "Power comes from knowing how to do something. People with power are people who know how to get things done. And sometimes knowing how to do something is virtually the same thing as having done it. So when we educate ourselves, we build power to accomplish our goals."

The B-WISER Institute will help young women achieve their goals in life.

The B-WISER Institute is an empowering experience.

Thank you for the opportunity to testify today before your committee. I will be pleased to respond to your questions concerning the B-WISER Institute.

Attachment: List of 1992 B-WISER Campers

Prepared by L. E. Elfner; July 2, 1992

B-WISER INSTITUTE PARTICIPANTS:
Buckeye Women in Science, Engineering & Research Camp
The Ohio Academy of Science at The College of Wooster, June 14-20, 1992

CITY	SCHOOL	CAMPER
Batavia	Amelia MS	Sabrina Joan Boobler
Bellaire	St. John ES	Jaclyn M. Ianzito
Bellaire	St. John ES	Kathy Anne Swarts
Berea	Rooks MS	Rosalind L. Kirkpatrick
Berea	Berea MS	Rebecca Ilene Bodner
Blakeslee	St. Joseph ES	Erica Ann Mohre
Byesville	Meadowbrook MS	Shannon Renee Harbaugh
Byesville	Meadowbrook MS	Alison R. Waske
Canton	Hartford JS	Kristee Lorraine Baylock
Canton	Pleasant View ES	Tina Kay Proudfoot
Carroll	Bloom-Carroll JS	Elizabeth Ellen Read
Cincinnati	Lockland JS	Lisa Nicole Farson
Cincinnati	Summit Country Day School	Michael Ann Gleitfelter
Cleveland Hts.	St. Louis ES	Amy Elizabeth Horvat
Columbus	Clintonville Academy	Emily Elizabeth Frye
Columbus	Dominion MS	Melinda L. Binder
Columbus	Franklin Alternative MS	Alyssa Renee Hayes
Columbus	St. Joseph Montessori ES	Isabel Fay Foley
Coshocton	Coshocton MS	Erica J. Talbot
Dayton	Fairview MS	Carrie Ann Lasley
Dayton	Precious Blood ES	Alicia Marie Daugherty
Dublin	John Sells MS	Emily Beth Swartzlander
Fayette	Gorham Fayette MS	Megan Denise Metcalf
Fayette	Gorham Fayette MS	Felicia June Morningstar
Findlay	Glenwood JS	Danielle Renne Cohan
Garrettsville	James A. Garfield MS	Katie Madelaine Clyde
Garrettsville	James A. Garfield MS	Carrie Ann Szabega
Grandview Heights	Grandview Heights MS	Adrienne Joan Waddell
Grove City	Our Lady of Perpetual Help	Lisa Catherine Schmidt
Hudson	Hudson MS	Heather Lynnette Roll
Ironton	Ironton JS	Alicia Danielle Smith
Lancaster	Fairfield Union JS	Wendy Lynn Keller
Lancaster	Fairfield Union JS	Mary M. Pool
Lancaster	Fairfield Union JS	Lucretia Dawn Wildermuth
Lebanon	Berry JS	Erin Marie Thatcheaka
Lima	St. Charles ES	Angela Marie Clay
Lima	St. Charles ES	Christina M. Lewis
Lockland	Lockland MS	Brigid Kathleen Erwin
Lockland	Lockland MS	Kristin Amy Loder
Louisville	Louisville MS	Kate Emery Rogers
Mansfield	Madison JS	Melissa Noel Walter
Mansfield	Ontario MS	Erin Ann Rittman
Mansfield	Ontario MS	Heather Marie Tsavaris
Mansfield	Ontario MS	Shauna Renee' Wilson
Martins Ferry	St. Mary Central	Ellen Marie Nicholson
Martins Ferry	St. Mary Central	Jennifer R. Stocker
Massillon	Pfeiffer MS	Emily Elizabeth Roach
Massillon	Pfeiffer MS	Jennifer C. Liesner
Massillon	Pfeiffer MS	Crystal Lynn Patterson
Massillon	Pfeiffer MS	Lacey Marie Shamp
Maumee	Gateway MS	Coryan Sue Willingham
Middlefield	Cardinal MS	Patricia Ann Hurd
Minerva	Hazen MS	Rebecca D. England
Minerva	Hazen MS	Michelle Annick Norton
Monroeville	St. Joseph ES	Sabrina Ann Chandler

-MORE-

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Continued . . . B-WISER INSTITUTE PARTICIPANTS:
Buckeye Women in Science, Engineering & Research Camp
The Ohio Academy of Science at The College of Wooster, June 14-20, 1992

CITY	SCHOOL	CAMPER
Mt. Gilead	Mt. Gilead JS	Trinity Noel George
Mt. Gilead	Mt. Gilead JS	Amy Renee McLain
Mt. Vernon	Mt. Vernon MS	Brooke M. Nelson
Ottoville	Ottoville ES	Kelly Jean Hicks
Peebles	Peebles JS	Beth Ann Armstrong
Peebles	Peebles JS	Lauren Brooke Worley
Perry	Perry MS	Yvette Marie Saucedo
Perrysville	Perrysville JS	Suzanne Elizabeth Lackey
Piqua	Piqua Catholic ES	Anne Marie Koenig
Piqua	Piqua Catholic ES	Colleen Anne LaFevre
Reynoldsburg	St. Pius X ES	Julie Hansel Glavan
Reynoldsburg	St. Pius X ES	Holly Elise Holzer
Reynoldsburg	St. Pius X ES	Megan Marie Wolfel
Rittman	Rittman MS	Caroline Dawn Imhoff
Rossford	All Saints ES	Katie Lee Jenkins
South Charleston	Miami View ES	Stephanie Ann Stewart
Springfield	Possum MS	Lisa Michelle Montanus
Springfield	Possum MS	Leigha N. Perkins
Springfield	Springfield Christian	Carrie Elizabeth Messinger
Springfield	Springfield Christian	Amanda Marie Williams
Springfield	St. Teresa	Stephanie Michelle Griffin
Springfield	St. Teresa	Emily Briggs Simpson
Steubenville	All Saints ES	Kristin Lee Rumlesmy
Sylvania	St. Francis Education Center	Christen Elizabeth Souders
Tipp City	Bethel JS	Leanne Goubeaux
Tipp City	Bethel JS	Jacquelyn Leanne Wells
Toledo	Christ the King School	Katie Elizabeth Young
Toledo	Ladyfield ES	Kelly F. Massali
Toledo	St. Joan of Arc ES	Elizabeth June Farkas
Troy	Troy Christian Schools	Stacey Lynn Ash
Urbana	Urbana JS	Crystal Renee Roberts
West Liberty	West Liberty-Salem	Gretchen Marie Smith
Westerville	Heritage MS	Ebony Bonner
Westerville	Heritage MS	Kellee Gooden
Wolfhurst	St. Joseph Central ES	Amy Renee Amato
Wooster	Triway JS	Elizabeth Ann Landers
Wooster	Triway JS	Catherine Sue Landers
Youngstown	St. Brandan's ES	Jamie Nicole Marich
Youngstown	Volney Rogers JS	Angela June Barwick

-end-

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July 14, 1992

The Hon. John Glenn
Chairman
Committee on Governmental Affairs
The United States Senate
Washington D.C. 20510-6250

Subject: Supplemental Testimony re Systemic Change in Science and Mathematics Education

Dear Senator Glenn:

We were pleased to respond to your letter of June 26, 1992 by having Ms. Elizabeth Obara testify on the B-WISER Camp at your field hearing on July 7, 1992 at NASA Lewis Research Center.

Enclosed you will find a supplemental statement as testimony concerning systemic change in Science and Mathematics Education. The statement is the background report which was prepared for The State of Ohio's 1990 successful bid for funds from the National Science Foundation's Systemic Change program. The emphasis of the statement is on **regionalization and collaboration** -- central themes of Project Discovery -- Ohio's proposal for systemic change.

Thank you for the opportunity to submit this additional testimony.

Sincerely,

Lynn Edward Elfner
Chief Executive Officer

LEE:

Enclosure

REGIONALIZATION OF SYSTEMIC CHANGE IN SCIENCE, MATHEMATICS, AND ENGINEERING EDUCATION

Background Paper

for the development of
Ohio's Proposal
to
The National Science Foundation's
Statewide Systemic Initiatives Program

by

Lynn Edward Elfner
Executive Officer
The Ohio Academy of Science

August 30, 1990

Background

Ohio is both very urban and very rural. Economic, cultural and geographic diversity abounds. Inheritance of this diversity is apparent in both the public educational system and in our economic conditions.

Inequalities in combined local, state and federal public support between Ohio's 612 public school districts are apparent. According to the Ohio Public Expenditure Council, the statewide average expenditure per pupil ranged in 1988-89 ranged from $2,807 in the rural western Ohio district of Botkins to $11,106 in the affluent, eastern Cleveland suburb of Beechwood. The statewide average was $4,004. State aid to public school districts ranged from 43.6 percent in the Columbus City School District to 69 percent in the Youngstown city schools. In teacher salaries, the statewide average for a teacher with a bachelors degree was $17,721; however, in the Akron district the average was $34,036, where teachers with more than 10 years' of experience totaled 70.4 percent of the district's teachers.

Current unemployment rates range from a low of 3.6 percent in Geauga County to 13.5 percent in Perry County. Changes in recent years in manufacturing employment vary considerably from county to county. Adams County has lost more than 50 percent of its manufacturing employment, but less 50 miles away, Clermont County, has increased its manufacturing employment 100 percent.

In 1980, 67 percent of Ohioans attained 12 years or more of school, but those in Adams County attained only 47 percent; in contrast, Geauga countians attainment was 76 percent. Likewise, 13.7 percent of Ohioans attained 16 or more years of education, but regional differences are reflected in 20.5 percent of Geauga countians and Adams countians attainment of only 5.4 percent. In Geauga County only 3.6 percent of the population was below the poverty level; whereas in Adams county more than 24 percent of the population is below the poverty level. Moreover, these disparities are not recent phenomena; they are deeply rooted in settlement patterns, changes in regional economies and in the aspirations of those who live there.

Ethnic patterns vary too. Most of rural Ohio is predominately white, with the clear exception of selected northwestern Ohio counties where the Hispanic influence is apparent. While all of Ohio's major cities have blacks, the black populations in Columbus and in the Dayton-Springfield areas rank in the top twelve nationally by income level.

The distribution of intellectual resources varies widely too. Except for three private institutions, Ohio University and Shawnee State University are the only Ohio four year institutions serving the rural areas of southeastern Ohio. In other rural areas, Bowling Green State University is located in the very rural northwestern Ohio and Miami University in a very rural region of southwestern Ohio. Both of these institutions, however, are only one county away from urban areas.

Urban areas including Akron, Cleveland, Columbus, Cincinnati and Dayton have an abundance of intellectual resources including major research institutions.

The influence of the Federal government is also unequal in Ohio. In Cleveland, NASA Lewis Research Center is a dominant employer of engineers. Similarly, Wright Patterson Air Force Base and the Air Force Systems Command dominate technical employment in the Dayton area. The Cincinnati region benefits from an historically rich legacy of research related to public health and safety, water quality and environmental sciences at NIOSH, the U.S. EPA Research Center, the University of Cincinnati, and Miami University.

Information processing is a forte of the Columbus economy due to such establishments as OCLC, Compuserve, Battelle Memorial Institute, Chemical Abstracts Service, The Ohio Supercomputer Center, AT&T and Bell Laboratories and numerous banks and insurance companies. Bank One has been recognized as one of the most innovative banks in the world.

Chemical industries are important to the regional economies in Akron, Cleveland, Cincinnati and other Ohio River valley cities. Manufacturing is important not only in major metropolitan areas -- especially in northeastern Ohio -- but also in virtually every county seat city in Ohio. The manufacturing employment of many northwestern Ohio counties exceeds the state average by more than 10 percent.

Although institutions of higher education including schools of education, school systems, business and industry and the voting public have a common interest in improving science, mathematics, and engineering education, they are faced with significant variations in local and regional assets and liabilities. Some intervening mechanism is necessary to increase the assets and to reduce the liabilities.

Weaknesses

Ohio's historical tradition of local self reliance no longer adequately serves the local needs in much of the State; similarly, state level policy makers and service providers often are too far removed from the problems to prescribe or deliver solutions. Accordingly, a regional approach, uniting disparate elements at a sub-state level into collaborative systemic change efforts is needed.

If the goals of science, mathematics and engineering education are to prepare students for useful careers in Ohio's changing economy and to prepare them to participate effectively in an increasingly technological society, then serious efforts are needed to restructure reform efforts along the lines of sub-state regional economies. Furthermore, those who affect that economy -- banks, federal, state and local agencies including educational institutions, business and industry, and the public at large must be forged into useful coalitions and partnerships for systemic change in science, mathematics and engineering education.

A cursory review of potential regions immediately raises issues which must be resolved. In most metropolitan areas, abundant resources are potentially available. In rural areas, which in many ways may be similar to inner city areas, access to resources and the aspirations of the population toward education are not adequate. A systemic change structure which may work in a major metropolitan area may need to be decidedly different in rural areas or in inner city.

One factor seems clear, however, and should apply regardless of the details of the structure in which it is implemented. Improving the quality of products and services by increasing employee involvement in the generation and implementation of ideas topped thirteen other activities ranked by an international survey of National Productivity Review subscribers. Improved management of information and better training on how to search for and suggest improvements were also important factors related to improvement in quality of products and services. When applied to education these findings dictate that teachers must be empowered if systemic change is going to occur. Moreover, innovation feeds on communication -- both informal and formal. Proximity of people to other people in creative and supportive environments is necessary to foster innovation.

The promotion of highly visible role models -- students, teachers, and workers in various careers -- and the promotion and replication of well documented, exemplary educational programs on a regional basis, may be the most effective means of empowering

innovation and discovery for systemic change in science, mathematics and engineering education.

How Many Regions?

When viewed from the perspective of sub-state regional economies, Ohio should have as many as a **dozen or more regions**. Even within major metropolitan areas, the economic differences, especially as they relate to urban school districts in comparison to adjacent suburban districts, are significantly different.

Most sub-state economic regions in Ohio transcend traditional political boundaries of cities, counties, townships and school districts. Basing the establishment of systemic change regions on the regional economies will require both careful economic and educational analyses as well as an acceptance of state and local political leadership. Expecting the regions to develop on their own, or assuming that the citizens will pull themselves up by their bootstraps -- when they may not have boots -- would be naive.

Some means is necessary to forge leadership groups in potential regions. Then, through a competitive proposal process, the State should provide funding for initiation of a lean management structure. The regions could build on their uniqueness and strengths and implement systemic changes in science and mathematics education of particular importance to that region.

To avoid excessive provincialism, the regions should be embedded with the issue of international competitiveness and the need for citizens to be capable of functioning as intelligent voters in an increasing technological society. National and state goals for science, mathematics and engineering education should be at the forefront of the systemic change efforts.

International competitiveness is the driving force behind educational reforms. The local school like the local factory is now an element in this competitiveness.

In most urban areas, intellectual resources at colleges and universities should be adequate for initiating and sustaining systemic change. Moreover, businesses in these areas -- especially if a business's headquarters is located there -- will have a keen interest in change. But in rural areas, the conditions are different. Many of the manufacturing plants in rural areas are "farm clubs" for Fortune 500 companies whose headquarters are in major urban areas in Ohio or in other states. They have been bought out by the parent companies or the parent companies have located or relocated firms in smaller towns and in suburban areas because of low taxes and low labor costs. Currently the commitment of these companies and of these communities to systemic change is weak.

Accordingly, leadership from such structures as the Ohio Cooperative Extension Service, the Ohio Rural Electric Cooperatives and other utilities, the Ohio Farm Bureau and major farm suppliers like Countrymark may be needed to work in rural areas. Many people point with pride to the transformation of the agricultural economy brought about in rural areas by the Cooperative Extension Service (OCES). Since the agricultural economy has changed, the OCES has been searching for new missions. The time may be right for their staff to emerge as systemic reform agents in rural Ohio.

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Steps to Create Regions

Those involved at the State level in systemic change efforts -- the Governor, the Ohio Department of Development, the Ohio General Assembly, the Ohio Department of Education, the Ohio Board of Regents, and The Ohio Academy of Science -- must work collaboratively to identify political, business and industrial, scientific, and educational leadership on a regional basis to plant the seeds for the growth and development of regional systemic change efforts. Central to this effort must be the identification and involvement of faculty, teachers and students; they are the professionals who know better than anyone what is needed and what will work.

Preliminary meetings should be initiated in prospective regions to explore the ways and means of establishing regions. These meetings should be highly visible and held at times and locations to facilitate involvement of faculty, teachers and students. Some vision of what needs to be accomplished should be communicated. Goals and objectives for science, mathematics and engineering education should be considered.

The proposed CEO's for Systemic Change should play a major role in convening the initial regional meetings.

A simple means should be devised for regional management structures; a small, board of directors, trustees or governing body should tend to the fiscal affairs. They could contract for accounting and fiscal management. Faculty, teachers and students and others should not be bothered with mundane aspects of organizational management. They should concentrate on developing and implementing action oriented systemic change agendas.

Funds appropriated by The Ohio General Assembly or obtained from the National Science Foundation should be used primarily for financing the action items on the regional systemic change agendas. A competitive proposal process would assure that a minimum of administrative costs would be incurred.

M^2SE: Making the Vision a Reality

by Gardenia Butler, M2SE Executive Director

The Minorities in Mathematics, Science and Engineering (M^2SE) Center

The Minorities in Mathematics, Science and Engineering (M^2SE) Center is dedicated to significantly increasing the number of students of color who are motivated and prepared for math, science, and engineering careers. Founded in 1989, the M^2SE Center is a Cincinnati–based, expanding consortium of business and industry, colleges and universities, and public school systems. The charter members are: Procter & Gamble, General Electric, Cincinnati Gas & Electric, Cincinnati Bell, the University of Cincinnati (Colleges of Applied Sciences, Arts & Sciences, and Engineering), Cincinnati Technical College, and the Cincinnati Public School District.

By 1996, M^2SE will be established in 51 schools in the Greater Cincinnati Area and will have made outreach contact with school systems throughout Ohio and other Midwest states. By the end of the five–year NSF funding, over 2,500 elementary, middle, and high school students and 250 teachers will be involved in the program.

The long–term vision of the M^2SE Center is to establish a Midwest consortium of public school systems, colleges/universities, and employers beginning in the Cincinnati region that will eventually extend throughout Ohio and the Midwest. The Center is structured to become the nucleus of the mathematics, science, and engineering preparation and training for students of color in the Midwest.

National Science Foundation CRCM Program

The M^2SE Center is a National Science Foundation Comprehensive Regional Center for Minorities. In 1991, NSF awarded the Center five–year funding based on the strength of its innovative program design and collaborative structure. M2SE is one of 13 national CRCMs. This NSF program is dedicated to making the pre–college pipeline for

math, science and engineering more accessible and more successful for students of color. The support of NSF, both through its funding and its generous sharing of expertise, has made it possible for M2SE to expand and refine its program. As a CRCM, M2SE is able to bring national resources and educational innovations on behalf of its program, the Cincinnati region, the state, and, most importantly, our students. Within a few years, we anticipate that M2SE, with the support of NSF, will be having systemic effects in our target area on the quality of math/science education, on the interest and motivation of students of color in these areas, and on our understanding of where educational improvements are needed.

Significant Collaborations

From its inception, M²SE has been a true collaboration of people, ideas, leadership, and resources from school districts, higher education, and industry. The fact the M2SE began as a unique collaboration of these areas was one of the key reasons it gained NSF support. Our collaborations are expanding almost daily. M2SE has established a formal relationship with the Ohio Math/Science Discovery Project, another NSF–supported program. This will allow both programs to impact math/science education throughout the state of Ohio much faster than originally planned.

The enthusiastic and generous involvement of business and industry takes many forms. Critically, there is significant financial support, both through direct funding and in–kind support. In our first year as an NSF CRCM, for example, we met and exceeded our commitment to cost–share every NSF dollar. In addition to financial support, business and industry supply math/science/engineering professionals who work one–to–one with our students as mentors, advisers, and friends. Classroom demonstrations, field trips, and materials are provided by the professionals, both in industry and high education.

In addition to large organizations, we have attraced the support and involvment of public

agencies, volunteer organizations, small businesses, community groups, and private individuals.

The National Need

The science, engineering, and mathematics education pipeline is not producing the number of professionals needed to meet our nation's scientific and technological needs. The National Science Foundation (NSF) predicts a shortage of over 500,000 science and engineering personnel within the next 20 years.

The Untapped Resource

Students of color represent a growing proportion of the pre–college population. At the same time, they are seriously underrepresented in the science, engineering, and mathematics (SEM) education pipeline and professions. In fact, based on our country's demographics, the science and engineering shortage can only be alleviated by tapping the potential of students of color.

The Solution

To attract and retain a significantly increased number of students of color in the science, engineering, and mathematics pipeline at all levels so that they are prepared and motivated to enter these career fields.

The Barriers

The solution can be simply stated, but there are a challenging set of barriers to overcome before it can become a reality.

- Of all American professions, math, science, and engineering currently have the smallest proportion of underrepresented women and men of color. Students of color rarely have relatives, neighbors, or even public figures to serve as role models and mentors in these fields. As a result, these students and their families often do not envision these career areas as possibilities. In reality, the career aspirations and

academic confidence of students of color are narrowed by as early as the 4th grade.

- Students of color all too often choose (or are placed in) pre–college curricula that remove them from the math, science, and engineering pipeline. Even if they remain in the college–preparatory pipeline, most students of color do not complete the level of mathematics and science courses necessary to enter and succeed in these fields at the college level.
- The educational resources—course materials, time–on–task, classroom methodologies—do not acknowledge the diverse needs of students of color. In addition, traditional teacher training does not develop the multicultural skills needed to realize the full potential of students of color.
- Many, if not most, SEM enrichment programs target students who are already committed and excelling. The number of students of color in the SEM pipeline can only be significantly increased by including the average student, who has the greatest educational need and potential for benefiting from enrichment and encouragement.
- The contributions of minority scientists and inventors are overlooked in our culture and only occasionally addressed in the curriculum. Without a recognition of heritage and the accomplishments of others, students of color, their families, and too many of their teachers don't believe in their abilities in these fields. These barriers within the science, engineering, and mathematics pipeline are exacerbated by general problems in the educational pipeline. These include the significant gap between the college–going rate of students of color and whites, the gap in standardized test performance, and high school drop–out rates.

The urgency of the need, combined with the complexity of the barriers, calls for early, systematic interventions and long–term commitments to sustained programs. The Minorities in Mathematics, Science and Engineering (M²SE) Center was founded to help make the solution a reality.

The M²SE Design

The M²SE design incorporates student enrichment, teacher development, parent involvement, and SEM professional resources to create an infrastructure for students of color within the science, engineering, and mathematics pipeline. The program strategies include:

- Early involvement of students and their families in SEM pipeline planning.
- Sequential, linked programs from the late elementary level into college.
- Teacher development that enhances mathematics and science knowledge, instructional skills, classroom resources, and racial/ethnic awareness.
- Inclusion of C average and above students in the M²SE groups.
- Enriched and expanded math/science experiences during the school year and in the summer.
- Exposure to SEM career opportunities through literature, field trips, speakers.
- Mentoring by SEM professionals and college students.
- Develop student confidence through participation in SEM competitions.
- Educational advising, including college planning, that supports student retention in the SEM pipeline.
- Tracking of student involvement and performance in the SEM pipeline from the first contact with an M²SE program through college graduation.

The M²SE implementation of these strategies results in a comprehensive program effort. When a school district joins M²SE, it becomes part of a collaboration that draws on a diversity of resources. The teachers and staff selected for school teams receive intensive training at the M²SE Summer Institute; with the school principal, the school teams design a year–long schedule for the after–school M²SE group. M²SE provides ongoing opportunities for teacher math/science development through in–service programs, workshops, and networking. Professional scientists, engineers, and

mathematicians provide hands–on demonstrations and host tours for M²SE groups. SEM professionals and college students serve as mentors for M²SE students. College faculty host presentations and on–campus activities. Summer SEM institutes provide M²SE students with academic enrichment, peer support, and motivation. M²SE liaisons with college and university programs provide summer research opportunities for advanced high school students.

7th and 8th Grades: Linchpin in the SEM Pipeline

M²SE addresses the entire pre–college SEM pipeline. Within a school district, the M²SE program is launched at the middle/junior high school level because it is a critical linchpin in the SEM pipeline for all students. The greatest number of students of color are lost from the SEM—and the college–bound—pipeline at the 7th and 8th grades.

The M²SE program targets this point in students' pre–college education as a critical opportunity to make a significant difference. After the middle school program is established within a district, "feeder" schools, both high school and elementary, are added, providing a linked sequence of programs. At the high school level, the M2SE emphasis in the 9th and 10th grades is on math/science skills enrichment, academic planning for advanced high school and college courses, and continued involvement with mentors and hands–on activities. M2SE emphasizes college awareness, college admissions test readiness, exposure to research, and summer experiences at the junior and senior high school level.

The elementary program, which was piloted in 1991–92 and is being launched in 4 elementary schools this fall, emphasizes general career awareness, hands–on involvment in science and math, and innovative demonstration materials such as Kitchen Chemistry and LEGO Logo. The Say Yes to Family Math program, developed by the Urban League, is a critical dimension of the elementary program, involving parents in the enrichment of student math skills and activities. As elementary students near the transition to the middle school, they are linked to their "feeder" middle school through mid–year gatherings of the two schools.

In–depth Look at M2SE and the Middle School Level

There are three critical dimensions to retaining students of color in the SEM pipeline at the middle/junior high school level: algebra, student academic focus, and awareness of SEM opportunities and requirements.

Algebra

Algebra is a valve that either retains or excludes students from the SEM pipeline. This doesn't mean just the actual course or a student's grade in it, but an entire set of issues concerning algebra. The issues include academic readiness for algebra, what grade algebra is taken in the SEM pipeline, teacher confidence in students' abilities to master algebra, parent understanding of algebra's importance, and teaching methodologies. Algebra is a "gatekeeper" course that determines whether or not students continue in a college–preparatory curriculum. Students, teachers, and parents must have confidence in the student's ability to master algebra. They must also have an appreciation for the usefulness of algebra in all future mathematics and science courses.

For the SEM pipeline, the issue is simple: students must have algebra in either the 8th or 9th grade in order to complete the number and level of high school math and science

courses necessary for admission and success in college–level SEM programs. If algebra is delayed to the 10th or 11th grade, students will not be prepared for college SEM programs, even though they may technically complete a college–preparatory high school curriculum.

There is clear evidence to support the benefits of commitment at the middle school level. *Against the Odds*, a College Board study conducted by Pelavin Associates, reported that African American and Hispanic students who took algebra and geometry in high school attended college at virtually the same rate as white students—approximately 80%, nearly double the college–going rate without this course combination. According to College Board President Donald Stewart, "The evidence is quite clear—students who complete geometry in the 10th grade go on to college."

Student Academic Focus

The middle/junior high school years are important transition years. In most cases, students encounter larger schools, a greater number of teachers, harder course material, more homework and tests, and less in–school work time. As the math and science material becomes more complex, parents are less and less able to help students with their studies. Students are expected to study, manage their time, and set priorities. At the same time, more activities (and distractions) are competing for time and attention. Students are expected to consider the long–term goals and choose school over fun.

Adolescents turn increasingly to peer groups for approval. Without a peer group that has academic effort and excellence as a norm, individual students have a difficult time adopting these goals. All the learning processes that support progress through the SEM pipeline—good study skills, cooperative problem–solving, independent research—can be taught, but they are rarely included in class instruction. Teachers, even when they

understand the need, have little time in their class schedule for these "extras."

These are demanding years for both students and parents. For students of color, there are additional difficulties. Many students of color do not have a family tradition of college attendance to set expectations and influence their decisions. The long–term goal of college, let alone a specific college program, can seem vague. Even if they expect to attend college, students of color (and their parents) often have little specific information about how the 7th and 8th grade relates to high school or college.

Students must develop an individual academic focus in the middle school years to make the choices and commitments necessary for remaining in the SEM pipeline.

Awareness of SEM Opportunities

Students at the middle/junior high school level are generally receptive to considering a wide range of career possibilities. Their interests are developing, not entrenched, and no one thinks they should have a firm career goal at this point. With encouragement, students at this age feel free to consider all the options. However, for students of color "all the options" are often artificially limited.

The lack of SEM role models and the lack of historical information have already been mentioned. Most of the SEM career opportunities are unfamiliar to students of color and their families. They have little meaning as long–term goals and rewards. In addition, advertisements, television shows, textbooks, and popular culture do not contribute to a broader career awareness. Students of color see little evidence in their daily lives that it would be natural for them to be physicists, chemists, computer scientists, or engineers. Without a personal vision, educational requirements seem irrelevant.

The M²SE Middle/Junior High School Program

The M²SE middle/junior high school program is designed to remove the barriers students of color face at this point, and support their continued progress in the SEM

pipeline. M²SE enriches and expands the SEM experiences through M²SE school groups during the academic year and through Summer Institute opportunities. The following is an outline of the structure and content of the M²SE middle school program.

Academic Year Program

The M²SE academic year program revolves around the M²SE group, supported by teacher training. The M²SE group is an after–school program, which meets twice a month throughout the school year.

School Team. The first step in the initiation of an M²SE middle school group is identification of a school team to plan and conduct the program. The school teams consists of a math teacher, a science teacher, a language arts teacher, and one other teacher, plus the school principal and counselor. One of the teachers serves as the school M²SE coordinator and is responsible for liaison with the M²SE Center. The four teachers receive stipends for their roles on the school team. There is also a program fund provided to support the M²SE group's activities.

Summer Institute. Before launching an M²SE program in the school, the math and science teachers attend the M²SE Summer Teacher Institute. The Summer Institute is a week–long program that includes SEM content sessions, computer–aided instruction training, and multicultural skills development. Institute participants engage in small–group discussions with teachers from all educational levels to develop resource networks and share interests and concerns. SEM college faculty and professionals provide sessions at the Institute, as do veteran M²SE teachers. The Institute materials provide teachers with activity outlines and resource materials for contacting speakers, mentors, and industry demonstrations and field trips.

Mini Institute. The Teacher Institute is followed by a two–day mini–institute. The other school team members join the math and science teachers to prepare the syllabus for the M²SE group for the academic year. This includes planning recruitment activities, scheduling activities and field trips, preparing a school profile to share with potential mentors, and integrating the M²SE activities and schedule with other school SEM programs.

M²SE staff work with the school teams on developing the syllabus. For the middle school program, the M²SE design requires an academic focus on SEM content areas, an emphasis on hands–on activities, career interest assessment and awareness programs, participation in SEM competitions, study skills development, and involvement of parents. When the school team has outlined its year–long program, M²SE staff assist in identifying college and industry resources for demonstrations and field trips.

M²SE Group Recruitment and Eligibility. The first month of the school year is spent recruiting and enrolling students in the M²SE Group. The school team presents information about M²SE to the school staff, circulates fliers, and announces the program at all–school assemblies. Students are recruited through teacher recommendations and/or student/parent applications. M²SE eligibility requirements are that students of color: have a C average in math, science, and language arts; have an interest in participation; have a parent commitment to support participation; have a teacher recommendation; and maintain their attendance and behavior during the group's activities. To be accepted into an M²SE group, both parents and students must complete a registration form committing to the goals and requirements of the group. At the end of the recruitment period, an orientation meeting is held by the school team for both parents and students. The year's schedule is outlined, parents are enlisted to assist in program activities, and students complete a preliminary career interest survey.

M²SE Group Activities. The academic year programs in M²SE middle schools generally alternate an activity meeting with a field trip. Throughout the year, students are engaged in projects that lead to participation in SEM competitions, either at the school level or area–wide. The following are examples of the various activities that occur during an M²SE middle school program.

Hands–On Activities
- Constructing Toothpick Bridges
- Mousetrap Car (paper vehicle design and construction)
- Egg Drop Container
- Math Counts
- Building Rockets
- Chewing Gum polymers
- Kitchen Chemistry
- LEGO/TC logo computerized designs

Demonstrations and Field Trips
- African History Museum, Xenia
- Children's Museum, Indianapolis
- Cincinnati Natural History Museum
- Cincinnati Zoo
- COSI Museum, Columbus
- College and university field trips, including Historically Black Colleges
- Local industries/corporations

Competitions
- Invention Convention Contest
- University Math Competition
- M²SE African American Scientist and Inventor Essay Contest
- University of Cincinnati Egg Drop Competition
- Science Exposition

Academic Support Activities
- Cooperative problem–solving activities
- Study skills groups
- Academic planning and course selection
- Mid–year gathering with feeder high school students and staff
- Recruitment for Student Summer Institute

Recognition Event. At the end of the academic year, all area M²SE students, parents, teachers, and mentors gather for a Recognition Event. All schools are acknowledged and individual student accomplishments are recognized. The Recognition Event establishes an annual time for M²SE students to realize that they are part of a systematic program that will support their interest and involvement through the next educational levels.

Student Tracking. At the end of the academic year, the school coordinator collects information on student academic performance, changes in career interests, and academic plans for the summer and the following year. Information about participating students is maintained in a relational database that tracks students throughout their educational careers. Even if students do not continue in an M²SE program, their academic information is tracked annually. The purpose of the database tracking is to assess program impact and trace student progress and commitment to the SEM pipeline.

Summer Institute

To enrich students' SEM experiences and extend the time devoted to SEM activities, M²SE sponsors a Student Summer Institute, conducted by the University of Cincinnati College of Engineering. The Institute is a five–week experience, conducted on the University campus; the last week, students live on campus. M²SE students are recruited from their school groups. To attend, students must be rising 8th graders or older. Courses are taught by college faculty and pre–college teachers. The Institute is based on the SEM courses students will be enrolled in for the coming academic year. Each student enrolls in a Summer Institute science, mathematics, and technical writing course. The course material previews the subject matter for the fall. In 1991, the math

and science courses offered were Algebridge, Algebra, Geometry, Biology, Chemistry, and Physics. The Algebridge and Algebra courses in particular serve to reduce anxiety about encountering an unfamiliar subject.

In addition to the Summer Institute course work, students participate in projects such as LEGO/TC logo and Technic Control I(TC) Technology Pack, Roller Coaster physics, paper vehicle construction, and other hands–on activities. For example, students who will be taking chemistry participate in practical chemical experiments led by chemists from Procter & Gamble and University graduate students. Field trips include plant visits, trips to historically Black colleges and universities, and other area SEM resources. Throughout the program, students work in state–of–the–art university laboratories and computer facilities.

Summary

The M²SE middle school program is working. Students rejoin the program year–to–year within the middle school, and enroll in the high school M²SE program at the next level. Students and their parents have incorporated the Summer Institute into their annual commitments. As a result, M²SE students have increased the time and effort devoted to SEM learning. Most importantly, they are gaining confidence and interest in these fields and are making commitments to remaining in the SEM pipeline.

The existence of the M²SE program within a school is also enriching the SEM program for all students. M²SE teachers incorporate their new M²SE materials in their classrooms; SEM professionals are making their demonstration and field trip resources available to other interested teachers; schools have adopted M²SE competitions as school–wide programs.

The M²SE program is expanding and is designed for replication by other collaborations. For additional information, please contact M²SE Center, 2220 Victory Parkway, Cincinnati, OH, 45220, 513/556-4018.

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On Enhancing Science Education in the Inner-City High Schools

Testimony to be presented by Prem P. Batra, Ph.D., Professor of Biochemistry, Wright State University, on July 7, 1992 before the Senate Committee on Governmental Affairs

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My name is Prem Batra and I am a Professor of Biochemistry with a joint appointment in the School of Medicine and the College of Science and Mathematics at Wright State University. I have taught at Wright State for the past 27 years. Before joining Wright State, I was at the University of Arizona, University of Utah, and Johns Hopkins University.

Wright State is a fully accredited state-assisted university with an enrollment exceeding 17,000 of which 3,700 are graduate and professional students. The university offers more than 100 undergraduate majors, 27 master's degree programs and several doctoral programs including a multi-disciplinary Ph.D. program in Biomedical Sciences. This latter program currently sponsors 48 students, of whom only 2 are African-American. The low number of minority students in the Ph.D. Program is typical of the national trends because of the serious shortage of qualified minority students graduating with baccalaureate degrees in the sciences.

It is no secret that minorities and women are underrepresented in the sciences. If we consider the data on minority students enrolled as first year medical students in U.S. medical schools, we find that the number of these students increased from about 300 in 1968 to about 1,500 in 1974, but since then the number has remained steady through 1991. In terms of percentages, the minority students constituted about 3% of the first year enrollment in medical schools in 1968; this increased to about 10% by 1974, and it has remained steady since then. The situation in other science-based professions is no different from the medical profession. In fact, the situation is even worse in many biological and physical science fields including engineering, where the number of minorities is actually decreasing. As is the case with minorities, the number of women receiving baccalaureate degrees in the natural sciences and engineering has also been declining since 1986. This trend must be reversed not only for maximizing the production of scientists and

engineers, a goal articulated by the President for America 2000, as well as by a congressionally-mandated task force, but also in the interest of equity.

One of the reasons that the minorities are underrepresented in the sciences is that many minority high school students are not academically prepared for college science studies. With this in mind, I would like to share with you the data of the National Assessment of Educational Progress survey conducted by the U.S. Department of Education in 1986. According to this survey, of the total 560,000 17-year-old African-Americans in the United States, only 2,800 (about 0.05%) possessed the ability to integrate specialized scientific information for use in problem solving - a prerequisite skill needed to succeed in science courses at the college level. Thus, it is crucial that efforts be made to increase the pool of academically prepared minority students who would go on to college and pursue careers in science. Furthermore, these students must be provided positive science experiences and enrichment programs, both in and out of school, as well as inspired instruction and accurate career information. It is through these enhanced opportunities, to learn and experience science at the precollege level, that these students will be motivated to pursue careers in science and technology.

This brings me to our model project that is based at Dunbar High School, a predominantly African-American inner-city Dayton Public School. The underlying objective of the model project is to improve the science academic performance of the inner-city high school students through a variety of intervention programs. These programs are designed to better prepare these students to succeed in college science studies and to motivate and encourage their entry into the science professions. The emphasis on precollege science education is particularly important since studies show that most students make career choices before graduating from high school. The project involves a partnership between Wright State University, Dunbar High School, the business

community, and the private sector organizations (Mead Corporation, Lifescan, Inc., Milton Roy Co., Procter & Gamble, Kettering Medical Center, and Marion Merrell Dow). According to the 1991-92 demographic data, the Dayton Public High Schools had a total enrollment of 6,487, and of these 4,410 (68%) were minority. Dunbar has a total enrollment of 869, and of these, 683 (79%) belong to minority groups - primarily, African-American. Over 50% of the Dunbar students are women and most of them (95%) are African-American. Because Dunbar has been recently designated as the magnet school for health sciences, we have, in cooperation with the Dayton Board of Education, focused on this high school. Being a magnet school, Dunbar can draw students from all areas of the city and thus has a potential for cultural diversity.

I appear before you to describe our efforts to enhance science education of minority and women high school students and to motivate them to pursue science-based careers. Four high school students and one high school science teacher who have participated in our program have accompanied me to these hearings. I want to share with you what they have to say about their participation in the program:

- Latrice Turpin, a recent graduate of Meadowdale High School, has this to say: "I knew I wanted to go to college, but I did not know what to major in. It is only after my participation in the Summer Research Program that I decided to major in pharmaceutical chemistry at Ohio State this Fall."
- Rashida Seldon is a senior at Dayton Christian High School and says: "The program greatly increased my interest in science, and I now have a yearning for the medical field."
- Elgin Kight is a senior at Dunbar High School and he indicates: "I never thought about doing research, but after completing this program, I found biomedical research more exciting than accounting. After high

school, I now plan to major in biology and do research in genetic engineering."

- Justina Brown, a senior at Northmont High School, says: "The Summer Research Program gave me more initiative to do my best in science and math courses. It is because of my participation in this program that I decided to pursue a career in the health sciences."
- Drucilla Veasley is a teacher and teaches biology at Dunbar High School. About her participation, Ms. Veasley has this to say: "This past school year was very successful for me, and I attribute that to my participation in the Summer Research Program last year. Not only did I develop long-term professional relationships with Wright State faculty, my summer experience also enabled me to do some of the hands-on experiments with my students in the classroom."

Our project has two components: (1) an academic year component, and (2) a summer component. I will briefly describe the activities and the strategies behind each component.

I. Academic Year Activities

The academic year component is based almost entirely at Dunbar High School and involves several objectives, strategies, and activities. These include:

(1) Updating and enhancing science courses to insure the accuracy of science content in high school classes, particularly in the area of molecular biology and biotechnology.

(2) Performing hands-on modern laboratory experiments.

The idea here is to make the students feel that science is fun and nonthreatening so that science courses become exciting opportunities to learn. Through these hands-on experiments and science projects, students develop record-keeping skills and acquire the ability to organize their data in the form of tables and figures.

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(3) Promoting active participation of students in the learning process.

This is accomplished by teaching students by posing questions. Students may be assigned an easy-to-read scientific paper. The paper then becomes the basis for discussion in the class. It gives the students experience in the interpretation of the experimental data presented in tables and figures, enhances their reasoning skills, and promotes critical and logical thinking. This process activates their curiosity about science and sparks their imagination.

(4) Orienting minority and women students to career needs, requirements, and opportunities in the natural sciences.

This involves taking students on field trips to university and private sector laboratories so that they can interact with minority and women scientists, as well as bringing minority and women scientists, physicians, and graduate and medical students into the classroom. The involvement of these individuals in the model project is very important to disadvantaged youths who may not know any scientists, doctors or other professionals in their own communities.

(5) Improving the professional status of science teachers and minimizing their sense of professional isolation.

This has been done by developing collaborative activities between Wright State faculty and the high school science teachers, such as writing joint grant applications, presenting a joint paper at a scientific meeting, writing a joint paper for publication, and developing new science courses. We are in the process of establishing electronic-mail linkages at the high school to promote communication, as well as give the teachers the ability to access libraries through the computer network that is well-established at Wright State and other universities. Promotion of the teacher enhancement activities through incentives can also bring about a permanent change in precollege science education.

(6) Bringing scientists from the private sector into the high school.

Such an involvement of the private sector in our partnership with the high school has several long-term beneficial effects, including an opportunity for summer employment for both students and teachers in research laboratories. The students develop a better understanding of, and an orientation to, career needs, requirements, and opportunities in science and technology.

I would be remiss if I did not acknowledge the help and support we have received from our private sector partners (Mead Corporation, Lifescan, Inc., Milton Roy Co., Procter & Gamble, Kettering Medical Center, and Marion Merrell Dow). Not only have they donated laboratory supplies, chemicals and scientific equipment for use by Dunbar students, many have also sent minority scientists for talks and demonstrations, as well as given students tours of their manufacturing and research facilities.

(7) Preparing and facilitating the transition of high school students for undergraduate science studies.

Several studies have suggested that because of their difficulty with introductory science courses, many African-American and Hispanic students are unable to complete college studies and drop out of the educational pipeline. Strategies are needed to prepare and facilitate the transition of these students from high school into college. In partnership with the science teachers, the Wright State faculty plans to offer in this fall quarter a modern introductory biology course for advanced and gifted students at Dunbar High School. Although the course will be taught primarily by the university faculty, we plan to involve the science teachers fully in every phase of the course, from the designing and planning stages to the actual teaching of the course. The course will

meet three days each week, two consecutive hours each day, for the 16-week semester at Dunbar. Students who successfully complete the course will be eligible to receive college credit. The emphasis of the course will be on hands-on laboratory experiments dealing with the cutting-edge modern molecular biology and biotechnology areas including gene cloning. We plan to set a high standard of expectation for student academic performance in this course and treat the students as if they are enrolled in college. This course will give the university faculty an opportunity to mentor on a continuing basis, and the students will acquire the confidence to enter college and remain in the scientific pipeline.

Up to this point, I have described the academic year activities. At this time, I must acknowledge the help of Mrs. Dora Carson who is a curriculum specialist at Dunbar High School and, as Co-Program Director, is in charge of the day-to-day activities at Dunbar. Mrs. Carson has accompanied us to Cleveland and is in the audience. Without her help and the support given by Principal Leon Love, we could not have made the progress we have.

II. Summer Research Program

I now turn to the extremely important summer component of enhancing science education of both minority and women high school students and motivating them to pursue science careers.

The Summer Research Program is a seven-week program and has two major objectives:

(1) Mentoring by professors while giving minority and women students a meaningful experience in scientific research, and

(2) updating the technical skills of the precollege science teachers and to familiarize them with modern research tools and techniques so that they can, in turn, bring a sense of excitement and current knowledge to the classroom.

In order to give minority and women students an opportunity for hands-on experience in scientific research and experimentation, we bring a select group to research laboratories at Wright State during the summer, assign each student a faculty mentor, and have the students participate for a period of seven weeks in ongoing research projects under the close supervision of faculty mentors. Thus, they work as Student Research Apprentices. This involvement in research permits the students to experience the application of theory taught in the classroom. The students' participation not only includes actual hands-on laboratory experience, but also literature research, so that they become familiar with the use of the library. Laboratory research participation may include preparing culture media, harvesting cells, performing simple and routine assays, preparing graphs and figures, data processing with a computer, and carrying out other simple, but essential, laboratory tasks designed to match and stretch their capabilities.

Students are recruited not only from Dunbar, but also from other inner-city high schools in the Miami Valley area. Students who have completed one year of chemistry, biology and mathematics are eligible to participate. Selection is based upon the student's motivation, professional goals, scholastic aptitude, accomplishments, maturity, recommendation from science teachers, a short essay describing what he/she expects to gain from participating in the program, and where possible, a letter from parents indicating parental commitment. An Advisory Committee consisting of three Wright State faculty and three high school teachers make the selection following personal interviews. The students work 8 hours a day for a 40 hour-week and are paid a stipend/salary of $1,000 for the 7 week program.

In addition to providing a meaningful hands-on research experience to minority and women students, we also provide a similar opportunity to precollege science teachers who are women, or belong to minority groups, or

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who teach a significant number of minority and women students. Participation in research during the summer allows the teachers to update their knowledge and skills in modern research tools and techniques so that they can, in turn, bring a sense of excitement to the classroom and stimulate student interest in scientific careers. Their involvement in the summer program has also led to year-round linkages between the teachers and the university faculty and has promoted further collaboration which has minimized a sense of professional isolation that many science teachers feel in their school environment. Selection is based upon the teacher's motivation, recommendation from the principal, desire to participate in research, and a statement as to how his/her students will benefit from the teacher's participation in the program, including how he/she would stimulate students toward careers in science. The teachers participate in research under faculty supervision. They are also involved in searching the literature in the library which strengthens the teacher's knowledge of the subject matter taught. Teachers are encouraged to accompany their faculty supervisors to professional meetings and to present papers based on their summer activity. Teachers work 8 hours a day for a 40 hour week and are paid about $2,000 for the 7 week summer program.

Every attempt is made to integrate the teacher participants and the Student Research Apprentices into a close working relationship with laboratory personnel, including undergraduate and graduate students. Every Friday at noon, all student apprentices, science teachers and the faculty mentors get together for a pizza party to enhance communication, to share enthusiasms, to describe what was accomplished during the week, and to iron out any difficulties or problems. This summer, we are also inviting to the Friday sessions minority and women scientists from the private sector to discuss, in simple language, their own research and to act as role models for the students. On Friday of the sixth week, all students and teachers give a brief

formal presentation of what was accomplished during the summer. On Friday of the seventh week, a luncheon-banquet is held at which parents/guests are invited and the faculty mentors present certificates of participation along with a gift purchased with their own funds to their student apprentice or teacher participant.

We began our Summer Research Program quite modestly in 1991 with 7 African-American students and one science teacher, although 31 students and six teachers wanted to participate. The 1991 summer program was so successful that 104 students and 17 teachers applied to participate in the 1992 summer program. However, we only had the resources to accommodate 17 students and six teachers. These individuals are presently working in faculty laboratories. I should note that all 7 students and the science teacher who participated in the 1991 summer program also wished to participate in the 1992 summer program. Four of those students (Latrice Turpin, Justina Brown, Rashida Seldon and Elgin Kight) and the science teacher (Ms. Drucilla Veasley), all of whom are participating for the second time, have accompanied me to Cleveland for these hearings.

I would also like to note that the Wright State faculty who acted as mentors in the 1991 summer had very positive responses to the program. Indeed, the program was so successful that while 12 faculty members had expressed an interest to act as mentors in 1991, this summer 41 faculty wished to act as mentors. Two other points of interest about the 1991 summer program are: (1) two students are coauthors, or their help is acknowledged, in scientific papers to which they contributed significantly (this is quite rare even for undergraduate students), and (2) one student, Latrice Turpin, recently graduated from high school and will be majoring in pharmaceutical chemistry at Ohio State University this Fall. (As I indicated earlier, Latrice has accompanied us to Cleveland.) The other six students from the

1991 summer program (three of those are also here) are doing extremely well academically and will be graduating in 1993; I am assured that they all plan to go on to college and major in one of the sciences. If resources become available, we plan to track the students for several years to see if they do indeed pursue scientific careers.

What more needs to be done?

(1) The Summer Research Program by itself is not enough. We need to implement year-round science enrichment programs for minority and women high school students. This may involve bringing them to the university and private sector laboratories after school hours and on Saturdays so that they can work as research apprentices throughout the year. Through such year-round mentoring programs, we can nurture, encourage, motivate, inspire and challenge minority and women students to pursue careers in science, including graduate work. The involvement of the private sector is critical since the students will gain a better understanding of the career opportunities available in science and technology. There is also a need for similar programs that target the precollege teachers. In addition, efforts are needed to encourage network formation between research scientists and educators. However, incentives (financial and otherwise) will have to be made available to attract the teachers to these programs.

(2) At the federal level, each major granting agency, such as NSF and NIH, should establish a separate precollege science enhancement division so that funds can be made available for innovative projects. It is my understanding that NSF is in the process of doing just that, and I applaud their effort for recognizing the need and the importance of science enrichment programs that target precollege students. Through its funding mechanisms, the federal government can do much to encourage and support the development of human resources for science and engineering.

(3) A stable multiyear funding base is critical if precollege science enrichment and intervention programs are to succeed. I emphasize the multiyear funding base because of our own experience last year. We were awarded a one-year model project grant for our work at Dunbar on September 23, 1991 - one month after the school had been in session. (The application deadline was January 31, 1991.) Because of the late notification, we were not as effective in influencing science education as we would have been had we been notified of funding before the school year had started. What made the situation even worse was that we had to turn around two months later to apply for a renewal of the grant for the next year and, interestingly, we had to include a progress report of what we had accomplished in the three-month period between September 23, 1991 and January 10, 1992! Sadly, the net result was that much of our effort for the first 3-4 months was expended in preparing and submitting the grant renewal application. A multiyear grant award would not only reduce the time spent on writing renewal applications each year, it would also give us, as well as the high school teachers, the school administration, and the parents of the high school youths, time to plan ahead. A multiyear grant would also give us the opportunity to track the students with respect to their academic success in college and career selection. I would also urge the granting agencies to move up the submission deadlines for grant applications so that we can be informed of the funding decision well before the school year begins. In this connection, I would like to mention that we submitted our grant renewal application for the 1992-93 academic year before the deadline of January 31, 1992; however, we still do not know of the funding decision. Since the school opens on August 24, there is a great deal of uncertainty about the level of our effort and work at Dunbar in the coming academic year. This

uncertainty is also affecting our plan to offer an introductory biology course for Dunbar students this Fall.

(4) There is a need to institute tutorial programs for students during and after school hours. Such programs should be staffed by academically strong undergraduate and graduate students who would act as teaching assistants. Funds are needed for this purpose. The teaching assistants would work closely with the teachers and would be under the supervision of the Program Director. Not only would they review the topical material that had been presented in class that day and answer questions, the tutors would bring in (with guidance and assistance from the University faculty) new problems/examples to illustrate concepts. The teaching assistants would also assist teachers with setting up laboratory experiments/demonstrations. Furthermore, they would be effective role models.

In addition to the after-school tutorial program, we need to institute a science/mathematics laboratory for students in the program to use during study periods. The laboratory should be staffed with teachers and teaching assistants who would assist students as they did homework.

(5) To further increase the pool size and quality of minority and women students for college science studies, we need to bring the science enhancement programs into the presecondary grades. And we need to ensure that the teachers teaching at these levels have the proper scientific background and resources to do the job effectively.

(6) The inner-city public schools lack the resources to make the drastic changes needed to improve science education, including the need to revise and modernize science courses. The schools can only do this cooperatively with help from the universities, and the university scientists must play a key role in this effort. Thus, I would urge that

steps be taken at the state level to promote linkages and partnerships between public universities and public schools; the ongoing partnership between Wright State and Dunbar High School can serve as a model. The Board of Regents and the State Board of Education, working together, can make this a reality.

(7) If school-based intervention programs are to succeed, we must involve and educate parents about science so that they can, in turn, stimulate their children's interest in science, help them set high career goals and complete rigorous course work. We have taken one step in this direction by inviting parents to attend the luncheon-banquet that is held at the end of the summer research program, during which students participating in the program are recognized and given certificates of participation and a gift from their mentors. We have had very positive responses from those parents, but we need to do more. We can help parents by organizing public evening forums on scientific issues of current interest (for example, AIDS, human nutrition and obesity, cholesterol and heart disease, oncogenes and cancer, implications of global warming, biological effects of drug/alcohol abuse, etc.). These forums should be organized in conjunction with Parent-Teacher Associations, church-related and other social groups.

(8) While the one-on-one interaction with high school students, as part of the Summer Research Program, is a very effective and successful strategy, it is also very time-consuming for faculty and has absorbed much of their time allotted for research activity during the summer. Up until now, the faculty have volunteered their time for the Summer Research Program. However, as this outreach program expands, faculty involvement needs to be encouraged and their efforts need to be recognized and rewarded. Participation in program activities should be counted in tenure and

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promotion decisions along with research productivity and teaching. Formation of partnerships among federal agencies, educational institutions (including universities), and the private sector should be encouraged for the explicit purpose of science enhancement at the precollege level. University research scientists have a critical role to play in this venture. However, they cannot do it alone. Federal and State Governments and the private sector must become full partners in this effort.

(9) Finally, I would urge the federal government and the private sector to make efforts to expand the job market for scientists in general, and for minority and women scientists, in particular. This in itself would be a great incentive for minority and women students and entice them to pursue careers in science.

To summarize, the Federal Government can help us enhance precollege science education in the following ways:

(1) create a separate precollege science enhancement division in each of the major funding agencies.

(2) institute a multiyear funding base.

(3) notify institutions of the funding decision well before schools open.

(4) encourage states to form linkages and partnerships between public schools and public universities.

(5) encourage business, industry, and other private sector organizations to form partnerships with universities, Boards of Education and schools.

(6) increase funding for the following purposes:

(a) tutorial programs during and after school hours,

(b) laboratory supplies and equipment,

(c) year-round research program for students and teachers,

(d) financial incentives for science teachers,

(e) parental involvement in their children's education, and

(f) tracking the academic success of the students in college, and their career selection and retention.

On behalf of all of us involved in this exciting endeavor, I thank you for providing us with this opportunity to describe our program and for your interest in and concern about enhancing precollege science education in general, and for minorities and women in particular.

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ADDENDUM TO THE TESTIMONY PRESENTED

BY PREM P. BATRA, Ph.D.

PROFESSOR OF BIOCHEMISTRY

WRIGHT STATE UNIVERSITY

AT A HEARING BEFORE THE SENATE COMMITTEE

ON GOVERNMENTAL AFFAIRS HELD ON JULY 7, 1992

Since the hearing held on July 7, 1992 before the Senate Committee on Governmental Affairs on **"Science and Math Education Reform"**, I have had the opportunity to study the Senate bill S.685 entitled, **"Summer Residential Science Academy Act of 1991,"** that Senator John Glenn has introduced. The concept of the Summer Science Academy for 7-12 grade students and its implementation are long overdue, and I commend Senator Glenn for introducing the bill. I also applaud his concern and efforts to enhance precollege science education in general and for talented, economically disadvantaged, minorities, and women in particular.

The Summer Science Academies will not only promote mentoring for 7-12 grade students, but will also provide these students an opportunity to interact with minority and women scientists. The involvement of these individuals as role models is particularly important for disadvantaged youths who may not know any scientists and other professionals in their own communities. It is also crucial that the students participate in the Academies on a multiyear basis, as the Senate bill S.685 calls for. A stable multiyear funding base will also provide the opportunity to track the Academy participants and graduates for several years. Tracking, unfortunately, is not often possible when educational enhancement programs are funded on a year-to-year basis.

I have two additional recommendations:

(1) The students should be given the opportunity to participate in the Academies even during the academic year - perhaps two Saturdays each month. This will not only permit mentoring on a continuing basis, but it will also make the summer program more meaningful for the students. Further, progress of the students in their academic work, as well as acquiring life skills, can be monitored throughout the year.

(2) A parallel program for science teachers who teach disadvantaged 7-12 grade youths should be initiated during the summer, as part of the Academies. The teachers would have the opportunity, through participation in research projects under the supervision of University scientists, to update their knowledge of modern research tools and techniques. This will enhance and modernize science content of courses and bring a sense of excitement to the classroom upon the teachers' return. Furthermore, their involvement in the Summer Academies will lead to long-term, year-round, linkages and partnerships between the teachers and the scientists, and promote collaborative activities. This network formation between research scientists and teachers will reduce professional isolation that many science teachers feel in their school environments.

Thank you for giving me the opportunity to comment on Senate bill S.685 and to have these comments added to my previously submitted testimony.

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Statement of
Spence M. Armstrong
Associate Administrator
Office of Human Resources and Education
National Aeronautics and Space Administration

before the
Committee on Governmental Affairs
United States Senate

July 7, 1992

Reform of our education system has been debated for years. However, what differentiates the reform environment of the 1990's from that of past decades is that major efforts are now focused on the accomplishment of a set of National Education Goals. These six goals for the year 2000 include increasing the high school graduation rate; enhancing student achievement and citizenship; making U.S. students first in science and mathematics achievement; and advancing adult literacy and lifelong learning.

To achieve the ambitious National Education Goals, this Nation must make a commitment to substantial change in the way we view education—in what and how we teach and learn. A reform effort of this scope requires not only addressing the structure, policy, and regulations of our school system, but also its culture. We must develop new cultural norms for education by encouraging cooperative, interdisciplinary, and lifelong learning. We must institutionalize in our schools a culture that embraces continuous improvement and lifelong learning.

In addition, systemic change, by definition, must address the needs of all students—including those groups traditionally underrepresented in science, engineering, and mathematics. To effect a cultural change in the Nation's school system, all reforms must be based on the premise that every student can and will learn.

A set of National Education Goals is not enough to transform the U.S. into "a nation of students." America 2000, the President's national strategy to achieve the National Education Goals, recognizes the need to support "break the mold" programs and replicate them. To achieve the National Education Goals, we must "walk the talk." Innovative schools and excellent teachers have always existed; however, in the past, they tended to be fragmented and isolated. For systemic reform to take hold, we need a coordinated approach to expand good ideas, replicate models that work, and provide all teachers with the opportunity to improve their skills.

The role of the Federal Government in the implementation of the National Education Goals is guided by the Committee on Education and Human Resources of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET/CEHR). The Department of Education and the National Science Foundation are leading Federal efforts in national education reform. The role of the mission agencies, including NASA, is one of support. In that capacity, our Vision is to support systemic change in the education system through expanding and enhancing the scientific and technological competence of all educators involved in the education reform movement. In doing so, NASA will be recognized by the education community as a premiere mission agency in support of the National Education Goals and national education standards.

However, reform of the Nation's education system cannot be realized through Federal commitment alone. Approximately 6% of the total spending for elementary and secondary education is from Federal sources. The remainder is primarily supplied by state and local governments. Given this, reform of the education system must be: led by national, state, and local education organizations; supported by Federal, state, and local governments; and ultimately, implemented by school administrators, classroom teachers, parents, and students.

Reform begins with pursuing immediate goals, e.g. changes in curriculum and instruction, improved teacher inservice, and innovative community, business, and school partnerships. However, these changes must be sustained to effect a long-term change in the culture of our schools—in the value we place on education and in the expectations we have of our students, teachers, and ourselves. The element which binds together all education reform efforts is the establishment of national standards—learning standards, teaching standards, and assessment standards—developed through consensus. NASA will support the development and implementation of these standards and the resultant state, district, and private curriculum frameworks by ensuring that our educational programs, activities, and materials are consistent with them.

NASA has begun a number of initiatives which directly support the National Education Goals, America 2000, the FCCSET/CEHR implementation priorities, and the emerging national standards. For example, in those states receiving National Science Foundation funding for Statewide Systemic Initiatives (SSI), NASA Centers will explore and develop linkages between existing Center education programs and the efforts of SSI. These linkages will include both precollege and higher education programs. In addition, our Centers will develop institutional linkages with state education personnel to ensure that programs address state and local education reform efforts.

One NASA-supported effort is the Tri-State Education Initiative (TSEI), a region of Mississippi, Alabama, and Tennessee that was officially established June 9, 1992, as the Nation's first America 2000 community to cross state lines. In cooperation with the Department of Education and other Federal agencies, NASA initiated a Total Quality Management (TQM)-based effort to identify the various customers to be served by the initiative, their wants and needs, and how to accomplish the National Education Goals in this tri-state area. The primary local desire identified in the original TQM-based analysis, repeated again and again by students, parents, and educators, was for a world-class education system that could really change the local economic cycle.

All 29 public school districts forming the Tri-State Education Initiative Consortium signed a Memorandum of Agreement outlining the parameters for cooperation. The National Education Goals and the America 2000 strategy provide the basis for these Consortium parameters, while the priorities developed by FCCSET/CEHR guide the involvement of NASA and other Federal agencies.

In addition, NASA has initiated a Tri-State Learning Center, a potential working laboratory for implementing the mathematics standards developed by the National Council of Teachers of Mathematics and the science curriculum standards under development by the National Research Council. Designed as a potential adaptive model, the program is being implemented with enthusiastic community involvement and support. What was once an underserved educational system is on its way to becoming a national model for meaningful systemic change.

In addition to implementing agencywide programs, each NASA Field Center develops and manages programs to address the specific needs of its local education community. For example, in a unique collaborative effort, NASA Lewis Research Center, the Cleveland Public Schools, and the Cuyahoga Metropolitan Housing Authority have initiated an educational program at Anton Grdina Primary Achievement School to encourage inner-city youth to embrace the discovery of science and mathematics. This program recognizes that total family involvement and support is a vital key to achieving and sustaining systemic change. However, too often a child's aversion to mathematics, science, and technology begins at home, where parents themselves are uncomfortable with these subjects. Consequently, the Anton Grdina project encourages parents to actively participate with the in-school and after-school activities, culminating in the building of a simulated space station habitat in the school.

This project has helped the district introduce a more inclusive hands-on approach to learning. It offers students a new cultural environment in which success in science and mathematics is perceived as attainable by every student, teacher, and parent. Increased attendance, improved test scores, and the dramatic increase of parental involvement and participation all point to the need to replicate this program's success. Anton Grdina

teachers will be teaching other teachers how to implement the approach in their classrooms and schools. Next year, the pilot will expand to another school in Cleveland and hopefully, one in Indiana.

Lewis has also been extremely proactive in its support of education reform efforts at the state level. One such initiative, entitled the Empowerment of Educators and Employees Program (EEAEP), is a "train the trainers" program in which Aerospace Education Specialists will work with educators in Lewis' six-state region to train them to work with other educators and students in their local areas. In the Cleveland area, an individual will be identified as the Lewis contact for each district, and we plan to have at least one educator in each county of Lewis' six-state region. The EEAEP will utilize the Lewis Computer Bulletin Board, the NASA Teacher Resource Room, and Regional Teacher Resource Centers and Space Grant institutions throughout the region to supply information to participants and coordinate activities.

The Aerospace Education Specialists will work closely with state departments of education to identify targets of opportunity where NASA resources may be most effectively utilized and leveraged to assist the greatest number of educators. They will also identify: all of the important state meetings at which NASA should have a representative; and the state and local programs which would benefit the most from NASA's active involvement.

Universities will be integrated into the process, emphasizing the preservice component of teacher enhancement. A pilot program at the University of Akron will link the Schools of Education and Engineering to provide preservice teachers with unique opportunities to experience mathematics, science, technology, and engineering applications first-hand before entering the classroom.

In addition, one of Lewis' education specialists has been invited to serve on a committee to advise the Ohio State Department of Education in the development of a model curriculum for science. This advisory committee will make recommendations to the curriculum writers regarding business, cultural, economic, pedagogical, and social considerations relevant to the model curriculum. NASA is honored to be a part of this process.

One of the most far-reaching efforts to support systemic change is to provide teachers with the tools they need to step away from the textbook and into the high-technology classroom of the next century. With the proliferation of educational technologies such as satellite communications and on-line computer information systems, every school, no matter how remote, can have immediate access to the latest information and educational materials.

For example, through NASA Spacelink, our on-line computer information service, educators, students, and the public can access aerospace-related information, including lesson plans and educational publications, by computer network. NASA Select, the Agency's internal communication service, offers informational and educational programs as well as real-time mission coverage, accessible in both the classroom and the home via satellite dishes and cable television systems. Our satellite videoconference series for educators allows teachers from all over the country to participate in NASA inservice workshops. Through these innovative distribution methods, utilizing the latest computer and satellite technology, we are able to offer every teacher the opportunity to participate in NASA's education program.

The scope of NASA's role in education is small when compared to that of the Department of Education or the National Science Foundation. However, by leveraging our unique resources, our facilities and personnel, we are using NASA's inspiring mission as a vehicle for teaching and for learning. As a Federal agency with a vested interest in the Nation's scientific and technological health, the educational health of this Nation is not only an opportunity for NASA, it is an obligation.

United States Committee on Governmental Affairs
Senator John Glenn, Chairman

Hearing Testimony

Ted Sanders
Superintendent of Public Instruction
Ohio Department of Education

NASA Lewis Research Center
Administration Building Auditorium
Cleveland, Ohio

July 7, 1992

The Challenge

The challenge before us, "By the year 2000, U. S. students will be the first in the world in science and mathematics achievement" is a formidable one. The problems of schools in general, and with mathematics and science education in particular, have not been brought about because of sudden deterioration. Throughout our history, traditional educational practices have provided the quality of teaching and learning necessary to sustain our nation as a world leader in virtually every endeavor. This traditional education, in which knowledge is fixed, teaching is telling, learning is absorbing and reciting, and authority is top-down, has met our needs through most of our agricultural and industrial ages.

The problems of mathematics and science education in schools today are linked to a transformation in the basic nature of society into a rapidly changing information age. According to John Naisbitt in his book *Megatrends 2000*, information and the ability to collect, maintain, and interpret it will be the most valuable commodity in the new age. To prepare Ohio students for this information age, education must be transformed. Such a transformation is characterized by the changing nature of knowledge, teaching as assisting performance, learning as the process of constructing knowledge through making sense of experiences,

and shared authority. Mathematics and science education for the information age should make use of modern tools, especially the computer and calculator, and provide more hands-on training, problem-solving activities, and opportunities for students to work together. It should assure that all students encounter the same core of learning regardless of economic circumstances and career aspirations as well as opportunities to pursue additional studies in depth; and it should seek to assess the broadest range of outcomes that are essential for mathematics and science literacy. Efforts to fundamentally alter any of the key features of the educational institution will have profound implications for beliefs and values, working relationships, and practices related to school culture, curriculum, assessment, instructional methods, special needs, and the needs of the learning community to understand and participate in the educational enterprise.

This transformation is the challenge of mathematics and science education reform. World-class literacy in mathematics and science is a key to the economic well-being of the country and to individuals' capacity to fully participate in a technologically-based, information-driven world society. A transformed mathematics and science education is absolutely necessary to empower ALL Ohio students for the information age.

What do we know about where we are?

Ohio is a diverse state, characterized by large metropolitan areas like Cleveland and remote populations of Appalachia. Ohio also represents a large segment of American society by having some of the wealthiest areas of the North Central region of the U.S. and some of the poorest areas of the country. Correspondingly, there is a wide range of teaching expertise and school conditions in Ohio. Ohio is home to many of the highest quality mathematics and science programs in the nation such as the Lakeland Area Center for Science and Mathematics in Lake County. But Ohio is also home to schools in dire need of assistance.

The results of the Ohio Ninth-Grade Proficiency Tests in Mathematics for the class of 1994 indicate that only about 43 per cent of Ohio students passed on their first attempt and only 68 per cent have now passed after four attempts on the test.

We know that, in general, Ohio students score close to the average on mathematics and science tests such as the National Assessment of Educational Progress when compared to students in other states. Our students do not compare so well when compared to students in other countries. According to statistics released by the *American College Test High School Profile Report*, Ohio has slightly fewer college-bound

students who plan to major in mathematics than other states and slightly more college-bound students who plan to major in science than other states. In all, less than 5 per cent of Ohio's college-bound seniors plan to major in mathematics or science.

It is clear that Ohio schools are in need of the kind of transformation in mathematics and science education I have described.

What is Ohio doing to transform mathematics and science education?

The Ohio Department of Education is committed to transforming mathematics and science education. In December 1991, Ohio became one of the first states in the nation to take up the gauntlet of America 2000 and proclaimed its Ohio 2000 plan. Within this plan, Ohio accepted the goals of America 2000 including Goal 4 that proclaims, "By the year 2000, U.S. students will be first in the world in science and mathematics achievement." At about the same time, the Ohio Mathematics and Science Advisory Commission, a broad-based group established by the State Board of Education, released its report, *Moving Toward the 21st Century: Strengthening Mathematics and Science Learning for All Ohioans*, which details recommendations for transforming mathematics and science education. Using this goal and these recommendations, the Ohio

Department of Education has accepted a leadership role for the transformation of mathematics and science education in Ohio and developed an action plan to guide this transformation.

Efforts have been under way since 1989 to bring state-of-the-art curricula in mathematics and science education to Ohio. Using the *Standards* published by the National Council of Teachers of Mathematics, the Ohio Department of Education developed *The Model Competency-Based Mathematics Program*, which guides course of study development in every school district in the state of Ohio. By the fall of 1992, each Ohio school district is required to develop a course of study according to the spirit and intent of the mathematics model.

The Model Competency-Based Science Program is now under development at the Department and will be available for use in the development of local courses of study in the fall of 1993. This model is being developed utilizing a wide range of expertise from within the state of Ohio and across the nation. It will benefit from the curriculum development efforts of the National Science Teachers Association (*Scope, Sequence & Coordination*), the American Association for the Advancement of Science (*Project 2061*), the Lawrence Hall of Science, and many others. In addition, the development of this curriculum model will benefit from

the evolving work of the National Academy of Sciences in the area of National Standards in science.

In the area of assessment, Ohio has an evolving proficiency testing program in many areas including mathematics and science. A proficiency test in mathematics for students in the ninth-grade was implemented in 1990. Science testing at the ninth grade level will join the mathematics test in 1995. These two tests join the areas of citizenship, reading, and writing as criteria for obtaining a high school diploma in Ohio. Proficiency testing at three other grade levels in each of these five subject areas will be added by the 1995-96 school year.

The results of the Ohio's existing proficiency testing program indicate that schools will need extensive help in transforming their programs to assure student success on the outcomes assessed. Ohio has recently joined 13 other states in a program to share resources and efforts to develop authentic assessments in science, namely, the State Collaboratives on Assessment and Student Standards, a project of the Council of Chief State School Officers.

The Ohio Department of Education is also collaborating with professional organizations, institutions of higher education, and funded projects to transform preservice and inservice education for Ohio

teachers- the most vital part of the transformation of the Ohio educational system. Unfortunately, it is an area where resources are stretched to the breaking point. In mathematics, the Ohio Model for Excellence in Mathematics (OMEM), a joint project between the Ohio Department of Education and the Ohio Council of Teachers of Mathematics, held over 60 regional meetings to prepare local leadership teams to facilitate the full and effective implementation of *The Ohio Model Competency-Based Mathematics Program*. Funded with inservice dollars provided through the state's portion of the Dwight D. Eisenhower National Program for Mathematics and Science Education, OMEM teams were able to initiate the systemic professional development needed to implement the model, but much more needs to be done.

Also funded by the Eisenhower program, 48 grants for partnerships between higher education and local schools were distributed for the purpose of inservice mathematics and science teacher education in 1991. This represented a slight increase in this effort from only 26 projects in 1989.

In 1990, Ohio successfully won one of the first ten State Systemic Initiative (SSI) grants administered by the National Science Foundation. Ohio's SSI, Project Discovery, divides the state into eight regions to

efficiently deliver teacher inservice instruction in mathematics and science. Project Discovery's goal is to develop leadership teams of teachers and scientist/mathematicians from each of the eight regions who will train mathematics and science teachers in their regions. These regions are governed at the local level by collaborative leadership groups that include persons from all areas of the learning community in the region. Over half of Project Discovery's funding comes from Ohio sources.

The regional delivery structure established by the Ohio Department of Education through Project Discovery is being articulated with all other Department efforts as an important vehicle to transform the entire educational system, beginning with the mathematics and science teaching force at the middle school level and quickly evolving to include instruction at all levels, the development of materials and techniques for schools, preservice teacher education, and the recruitment of the rest of the Ohio community, including Ohio businesses and industries, parents, and other community members.

We believe that the entire community of learners must be involved in order for a complete transformation of the educational system to occur.

What can the federal government do?

By the fall of 1993, Ohio will have mathematics and science curricula based on world-class standards. That is the easy part. The hard part will be the translation of those ideas, techniques, and materials into the schools. Paper transformations can be accomplished easily. *The real transformation will occur in individual buildings and classrooms in every community in Ohio, from Cincinnati to Columbus, from Cleveland to Gallipolis, and from Bryan to Ashtabula.* The transformation must reach all of Ohio's 50,000 mathematics and science teachers and all of the 2 million students of our state.

The assistance provided by the Eisenhower program for Mathematics and Science has been helpful, but it is simply not enough. But if we are to attain our goal of "the best in the world" through a transformed educational system, and if we are to have a truly mathematically and scientifically literate citizenry, decision makers who have been empowered to succeed in an information society, then we must find additional resources for implementing of the shared vision for the transformation.

Within this shared vision for transforming mathematics and science education, are several priorities that must be supported at the federal

level. A new infrastructure for education must be built at the community level. Everyone in the school community must understand and accept his or her stake in the transformation of science and mathematics education. Additional federal dollars must be targeted for collaborative efforts at the community level. For example, more federal program approval decisions need to be made based on the degree to which local businesses and industries, community leaders, social agencies, and citizens in general are involved in educational reform.

A critical need exists for federal support of the redesign of whole schools especially for the redesign of mathematics and science education. The development and implementation of mathematics and science programs based on world-class standards such as the *Ohio Model Competency-Based Mathematics Program* and the *Ohio Model Competency-Based Science Program* must be a federal priority.

Developing preservice and inservice programs that help mathematics and science teachers excel in redesigned schools represents another critical priority that requires increased federal support. Programs based on the trainer-of-trainer model such as Project Discovery and the Ohio Model for Excellence in Mathematics will have a tremendous payoff in the future in terms of true systemic reform. All implementation

and professional development efforts inevitably succeed or fail based on the powerful nature of teacher-student interactions. Every teacher must be touched by the school transformation process on an ongoing basis. Many trainers who share in the vision of the transformation of mathematics and science education are needed.

Our mathematics and science transformation will truly be the gatekeeper to a competitive and prosperous America. We in Ohio invite the federal government to increase its commitment to strong learning communities and become a full partner in the transformation of Ohio's schools. In order for all students to have access to a world-class education in mathematics and science, we must all join in the spirit of America 2000 and transform education for the information age.

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